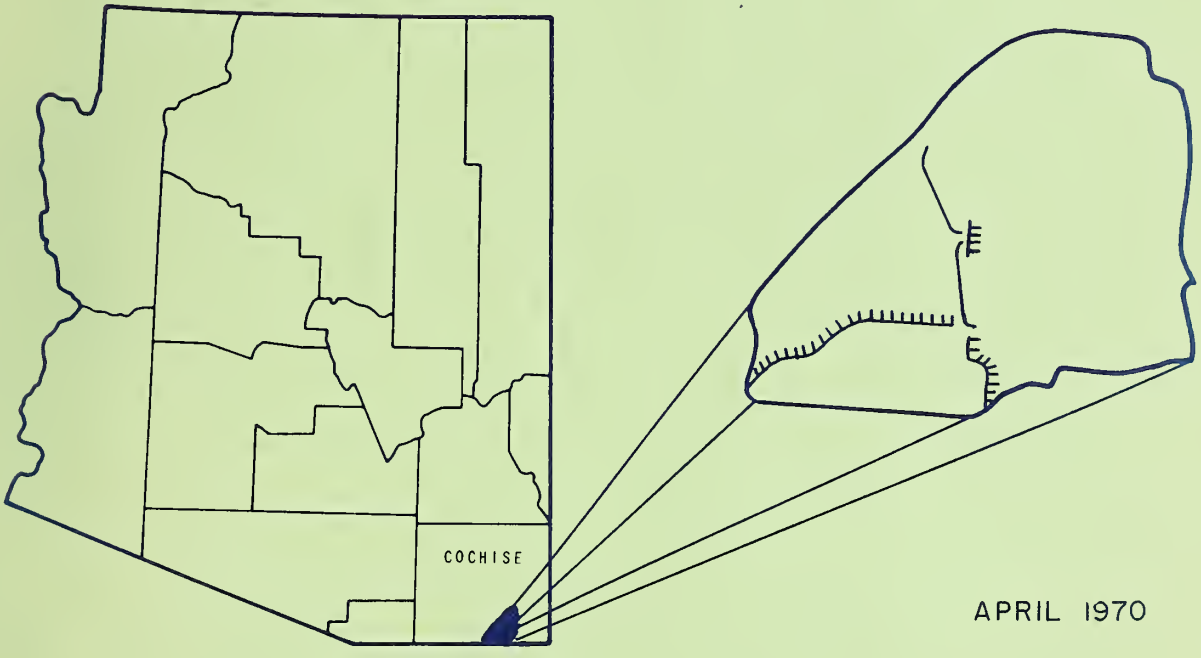
WATERSHED WORK PLAN

PERILLA MOUNTAIN WATERSHED

COCHISE COUNTY, ARIZONA



APRIL 1970

Prepared under the authority of the Watershed Protection & Flood Prevention Act (Public law 566, 83rd. Congress, 68 Stat. 666) as amended.

U. S. DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE

USDA-SCS PORTLAND, OREG. 1970

Watershed Work Plan
Perilla Mountain Watershed

Cochise County, Arizona

Prepared Under the Authority of the Watershed Protection and Flood Prevention Act (Public Law 566, 83d Congress, 68 Stat. 666), as amended.

Prepared by: The City of Douglas

The County of Cochise

The Whitewater Draw Soil Conservation District

With Assistance by:

U. S. Department of Agriculture, Soil Conservation Service

April 1970

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Perilla Mountain Watershed, Arizona

WATERSHED WORK PLAN AGREEMENT

between the

City of Douglas
County of Cochise
Whitewater Draw Soil Conservation District
(hereinafter referred to as the Sponsoring Local Organization)

State of Arizona

and the

Soil Conservation Service
United States Department of Agriculture
(hereinafter referred to as the Service)

Whereas, application has heretofore been made to the Secretary of Agriculture by the Sponsoring Local Organization for assistance in preparing a plan for works of improvement for the Perilla Mountain Watershed, State of Arizona, under the authority of the Watershed Protection and Flood Prevention Act (Public Law 566, 83d Congress; 68 Stat. 666) as amended; and

Whereas, the responsibility for administration of the Watershed Protection and Flood Prevention Act, as amended, has been assigned by the Secretary of Agriculture to the Service; and

Whereas, there has been developed through the cooperative efforts of the Sponsoring Local Organization and the Service a mutually satisfactory plan for works of improvement for the Perilla Mountain Watershed, State of Arizona, hereinafter referred to as the watershed work plan, which plan is annexed to and made a part of this agreement;

Now, therefore, in view of the foregoing considerations, the Sponsoring Local Organization and the Secretary of Agriculture, through the Service, hereby agree on the watershed work plan, and further agree that the works of improvement as set forth in said plan can be installed in about four years.

It is mutually agreed that in installing and operating and maintaining the works of improvement substantially in accordance with the terms, conditions, and stipulations provided for in the watershed work plan:

1. The sponsoring Local Organization will acquire without cost to the Federal Government such land rights as will be needed in connection with the works of improvement. (Estimated cost $667,170.)

2. The Sponsoring Local Organization will acquire or provide assurance that landowners or water users have acquired such water rights pursuant to State law as may be needed in the installation and operation of the works of improvement.

3. The total construction cost of the structural measures will be borne by the Service. (Estimated cost $3,080,220.)

4. The total engineering cost will be borne by the Service. (Estimated cost $924,070.)

5. The Sponsoring Local Organization and the Service will each bear the cost of Project Administration which it incurs, estimated to be $30,800 and $308,020 respectively.

6. The Sponsoring Local Organization will obtain agreements from owners of not less than 50% of the land above each reservoir and floodwater retarding structure that they will carry out conservation farm or ranch plans on their land.

7. The Sponsoring Local Organization will provide assistance to landowners and operators to assure the installation of the land treatment measures shown in the watershed work plan.

8. The Sponsoring Local Organization will encourage landowners and operators to operate and maintain the land treatment measures for the protection and improvement of the watershed.

9. The Sponsoring Local Organization will be responsible for the operation and maintenance of the structural works of improvement by actually performing the work or arranging for such work in accordance with agreements to be entered into prior to issuing invitations to bid for construction work.

10. The costs shown in this agreement represent preliminary estimates. In finally determining the costs to be borne by the parties hereto, the actual costs incurred in the installation of works of improvement will be used.

11. This agreement is not a fund obligating document. Financial and other assistance to be furnished by the Service in carrying out the watershed work plan is contingent on the appropriation of funds for this purpose.

    A separate agreement will be entered into between the Service and the Sponsoring Local Organization before either party initiates work involving funds of the other party. Such agreement will set forth in detail the financial and working agreements and other conditions that are applicable to the specific works of improvement.

12. The watershed work plan may be amended or revised and this agreement may be modified or terminated, only by mutual agreement of the parties hereto.

13. No member of or delegate to Congress, or resident commissioner, shall be admitted to any share or part of this agreement, or to any benefit that may arise therefrom; but this provision shall not be construed to extend to this agreement if made with a corporation for its general benefit.

14. The program conducted will be in compliance with all requirements respecting nondiscrimination as contained in the Civil Rights Act of 1964 and the regulations of the Secretary of Agriculture (7 C.F.R. 15.1-15.12), which provide that no person in the United States shall, on the grounds of race, color, or national origin, be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any activity receiving Federal financial assistance.

City of Douglas

By Paul Huber Jr.

Title MAYOR

Address Douglas, Ariz. 85607
Zip Code

Date 3/23/70

The signing of this agreement was authorized by a resolution of the governing body of the City of Douglas adopted at a meeting held on SEPTEMBER 8, 1969

City Clerk Jonathan F. Denney

Date 3/23/70

County of Cochise

By John F. Gillan

Title Cochise County Supervisor

Address Douglas Ariz 85607
Zip Code

Date March 23, 1970

The signing of this agreement was authorized by a resolution of the governing body of the County of Cochise adopted at a meeting held on November 3, 1969

Secretary Myrtle M. Conn

Date March 23, 1970

Whitewater Draw Soil Conservation District

By Lawrence McDaniel

Title Supervisor Chairman

Address 1553-105 Douglas
Zip Code

Date 3/23/70 85607

The signing of this agreement was authorized by a resolution of the governing body of the Whitewater Draw Soil Conservation District adopted at a meeting held on 10-14-69

Secretary Homer McBride

Date 3-23-70

Soil Conservation Service
UNITED STATES DEPARTMENT OF AGRICULTURE

By _____
(Administrator)

Date _____

Perilla Mountain Watershed
Watershed Work Plan

Cochise County, Arizona

April 1970

SUMMARY OF PLAN

Size and Location

The watershed is located in south central Cochise County, Arizona on the west slope of the Perilla Mountains and extends southwesterly to Whitewater Draw. Part of the southern boundary lies along the border of the Republic of Mexico. This watershed covers an area of 32,585 acres and includes the city of Douglas and the town of Pirtleville.

Sponsoring Organizations

The work plan was prepared by the city of Douglas, the county of Cochise, and the Whitewater Draw Soil Conservation District. Technical assistance was furnished by the Soil Conservation Service of the United States Department of Agriculture.

Watershed Problems

Eleven major floods have occurred in this watershed since 1904. Minor floods damage roads, utilities, and urban properties annually. Over 2,900 cultivated acres have gone out of production due to past inundations and other economic conditions. Most floods originating in the Perilla Mountains result from high intensity cloudburst type summer storms. Flood flows from these storms inundate roads, the County fairgrounds, the Douglas airport, and residential and commercial developments.

Continued urban expansion will result in an increase in floodwater and sediment damages.

Works of Improvement to be Installed

Works of improvement proposed in this plan include land treatment measures and structural works needed to reduce floodwater, sediment, and erosion damages to the floodplain area.

The Whitewater Draw Soil Conservation District will continue to stress application and maintenance of soil and water conservation practices. Land treatment measures to be installed and practices to be applied include: brush control, deferred grazing, proper grazing use, range seeding, and a pond.

Two floodwater retarding structures, two floodways and one diversion will be installed. All structural measures are designed to control the runoff originating from storms expected to occur once in 100 years. The project will reduce floodwater and sediment damages by about 76 percent. The installation period for this project is 4 years.

The total project cost of $4,720,410 will be borne by P.L. 566 and other funds as shown below:

Item	Project Costs (Dollars)		
	P.L. 566 Funds	Other Funds	Total
Land Treatment Measures	0	18,150	18,150
Structural Measures - Flood Prevention	4,004,290	697,970	4,702,260
Total	4,004,290	716,120	4,720,410

BENEFITS AND COSTS

Average annual benefits and costs of proposed structural measures are estimated at $585,030 and $253,380, respectively. The ratio of benefits to costs is 2.3:1.0.

ARRANGEMENTS FOR INSTALLATION, OPERATION, AND MAINTENANCE

Land treatment measures will be applied and maintained by the Whitewater Draw Soil Conservation District cooperators.

The city of Douglas will construct, operate, and maintain the structural works of improvement. Operation and maintenance agreements will be executed prior to issuing invitations to bid. Average annual operation and maintenance costs for structural measures are estimated at $22,170.

DESCRIPTION OF THE WATERSHED

PHYSICAL DATA

LOCATION

The Perilla Mountain Watershed is located in the south central portion of Cochise County, Arizona. It extends from the west slopes of the Perilla Mountains to Whitewater Draw. Aqua Prieta, Sonora, Estados Unidos Mexicanos, the twin city of Douglas, is immediately adjacent to the southern most boundary of the watershed area. The city of Douglas and the town of Pirtleville are within the watershed (see Figure 1). Highway U.S. 80 traverses the length of the watershed. Highway U.S. 666 originates in Douglas and is the connecting route to Colorado via Willcox, Arizona.

LAND USE AND STATUS

The watershed area contains 32,585 acres of which 22,720 acres are privately owned, 8,975 acres are state owned, and 890 acres are Federal lands administered by the Bureau of Land Management (see Figure 3).

Ownership and Use	Acres	Percent of Area
Private Lands		
Urban and Commercial	4,920	15.1
Rangeland	17,800	54.7
Subtotal - Private Lands	22,720	69.8
State Lands		
Rangeland	8,975	27.5
Subtotal - State Lands	8,975	27.5
Federal Lands		
Rangeland	890	2.7
Subtotal - Federal Lands	890	2.7
TOTAL	32,585	100.0

LAND RESOURCE UNITS

Land resource units are geographic land areas characterized by particular combinations or patterns of topography, soils, climate, water resources, land use and vegetative cover. Three of these, the Hills Unit, the Slopes Unit, and the Valley Unit exist in this watershed (Figure 3). These Units are further described under Topography, Soils, and Cover Conditions in this section of the work plan. The areal extent of land within these units is as follows:

Resource Unit	Acres	Percent of Area
Hills	4,800	14.7
Slopes	12,900	39.6
Valley	14,885	45.7
TOTAL	32,585	100.0

TOPOGRAPHY

Elevations above mean sea level vary from 3,900 feet at Whitewater Draw to 5,900 in the Perilla Mountains. The general slope is to the southwest.

The Hills Unit is located in the extreme eastern portion of the watershed with very steep slopes ranging from 25-75 percent.

The Slopes Unit is characterized by gently rolling to hilly areas. The slopes vary from 5-25 percent.

Topography in the Valley Unit ranges from moderately sloping to nearly level with slopes varying from 1-10 percent.

GEOLOGY

The watershed area is part of the Mexican Highland section of the Basin and Range physiographic province. The portion of the Perilla Mountains within the watershed boundary is composed mainly of sedimentary and extrusive igneous rocks. The sedimentary rocks consist of Cretaceous shale, sandstone, and limestone. The extrusive igneous rocks are mainly Tertiary rhyolite

with lesser amounts of Cretaceous andesite. Rattlesnake Hill is composed of Quaternary basalt and cinders. Gentle alluvial slopes extend basinward from the mountains and are composed of inter-bedded lenses and layers of gravel, sand, silt, and clay. Shallow occurrences of caliche are common in the area. The valley fill, in places, is inter-bedded with quaternary basalt. A small area containing gypsum deposits of lacustrine origin is found in the valley fill near the mountains.

SOILS

The Hills Unit is characterized by very shallow stony soils with rock outcrops. Surface soils are loam to clay loam.

Soils in the Slopes Unit are primarily moderately deep and deep, but many have lime cemented hardpans and all are calcareous throughout. Surface textures are loams and sandy loams.

The Valley Unit consists primarily of deep loam, clay loam, and clay soils.

COVER CONDITIONS

Vegetative cover and range conditions for the land resource units follows:

The Hills Unit cover aspect is grassland with scattered ocotillo, yucca, and cacti. Perennial grasses are sideoats grama, black grama, slender grama, plains lovegrass, cottontop, cane beardgrass, and three-awn. Range condition is good to excellent. Overall, vegetative ground cover on this unit is estimated at 30 percent.

The cover aspect of the Slopes Unit is predominantly brush with a grass undercover. Creosote bush, mesquite, whitethorn, and tarbush are the principal brush species. Perennial grasses are fluffgrass, tobosa, bush muhly, sideoats grama, cottontop, and three-awn. Range condition varies from poor to fair. Average ground cover is estimated to be 15 percent.

The Valley Unit consists of the floodplain and includes the urban, commercial, and industrial areas. Cover aspect of the scattered rangeland is predominately brush with perennial grasses in protected areas along the water courses. Generally, range condition is poor with ground cover estimated to be ten percent or less.

STREAM CHANNEL

There are no perennial streams within the watershed. Whitewater Draw forms two miles of the southwest boundary. Drainage is generally to the southwest. Incised dendritic drainage patterns exist in the Hills and Slopes Units. Channel gradients in these units are steep with some areas of active gullying. Stream channels become less defined as the gradients decrease in the Valley Unit. These channels do not have the capacity to contain the less frequent floods, thus floodwater carried into the area by defined channels spreads out over the floodplain as sheet flow before entering Whitewater Draw.

CLIMATE

The average growing season at Douglas is 213 days. Temperatures range from 6 to 111 degrees Fahrenheit (F) with a minimum mean of 46° F and a maximum mean of 79° F. The annual average mean temperature is 63° F.

There are two precipitation seasons, summer and winter, occurring during the average year. The average annual rainfall varies from 12 inches at Douglas to around 14 inches in the upper portion of the watershed. Approximately 50 percent of the annual precipitation comes in July and August. At this time of the year moist, unstable air advances into the state from the Gulf of Mexico, producing moderate to heavy afternoon showers and thunderstorms over the heated land surface. This convective activity is most pronounced in the vicinity of the mountains.

Winter precipitation in the area is not so consistent as that of summer, varying from year to year in both amount and frequency. Winter storms are associated with the middle latitude storms moving eastward from the Pacific Ocean across Arizona. These storms normally are gentle to moderate showers and sometimes include snow which may last for several hours.

WATER RESOURCES

Water utilized in the watershed is obtained from groundwater and limited surface runoff originating principally from summer precipitation. The Douglas Groundwater Basin, located in the Sulphur Springs Valley, is approximately 25 miles wide and 45 miles long with Douglas being at the southern extremity. Depths to groundwater range from 40 to 130 feet.

Groundwater is the principal water resource. As water use exceeds replenishment from surface sources, groundwater levels have declined on the average of one foot annually. Whitewater Draw has its base flow supplied by groundwater from the alluvium of the Douglas Basin. The general movement of groundwater is southward to Mexico. The groundwater supply appears adequate for projected needs.

The city of Douglas obtains its municipal water from wells in and adjacent to the city.

Surface runoff exists only as floodwater in this watershed and drains into Whitewater Draw. There are seven stock ponds that impound surface runoff, however, they have a negligible effect on the total surface runoff.

E C O N O M I C D A T A

The economy of the Perilla Mountain Watershed is based primarily on manufacturing and trades. Douglas is the financial, industrial and commercial center of southeastern Arizona. Its trade area, including Aqua Prieta, serves an estimated 35,000 purchasers of consumer goods.

Since 1950 the population of Douglas, Pirtleville, and the surrounding urban fringe area has increased more than 30 percent. Today there are 14,000 people in the urban areas of the watershed. Seasonally, the population of Douglas increases as agricultural workers move in to harvest, transport and process crops grown outside the watershed.

According to a 1964 employment census of Douglas, wholesale-retail trades and miscellaneous services accounted for approximately 50 percent of the working population, manufacturing 23 percent, and agricultural workers the remaining 27 percent. The Phelps-Dodge Smelter located adjacent to the watershed is the largest single employer.

Agricultural production within the watershed is negligible, however, agriculture is a mainstay of the Douglas area economy. Over 50,000 acres of irrigated land are within close proximity to the watershed. Crops grown include alfalfa, chili, cotton, lettuce, grain sorghums, small grains, peaches, and miscellaneous vegetables.

Livestock also represents a major part of the agricultural economy. Douglas is a large port of entry for Mexican cattle. The recent completion of the Republic of Mexico's new highway EUM 19 from Cananea to Agua Prieta, Sonora is expected to increase all imports.

Since 85 percent of the watershed is rangeland, livestock production represents the major portion of the agricultural economy derived entirely from within the watershed.

The 14 ranches are all owner-operated, family sized units. There are no ranch units with more than 1-½ man-years of hired labor. Local operators often supplement farm income by outside employment.

Transportation facilities and accessibility to market are good. In addition to the three major highways, U.S. 80, U.S. 666 and EUM 19, the Southern Pacific Railroad branch line provides rail service to Douglas. Air, bus and motor freight service is also available.

Currently, the Coronado Resource Conservation and Development project is being organized in the southeast portion of the state, which includes this watershed.

L A N D T R E A T M E N T D A T A

This watershed is within the Whitewater Draw Soil Conservation District. The District has an active program of soil and water conservation. Twelve of the fourteen local operators are Soil Conservation District cooperators and ten of these have basic ranch plans. Approximately 90 percent of the private land, including land leased from the State of Arizona for agricultural purposes, is covered by cooperative agreements and about 80 percent of the planned practices have been applied. Installations of the remaining planned practices is limited by the financial capabilities of the ranch operators. All planned practices have been applied on Federal lands.

The land capability classes for the land resource units are: Hills VIs, VIe, VIIs and VIIe; Slopes IIIs, IVs, IVe, VIIs, and VIIe; and Valley I, IIs, IIIs, IVs, and VIIs.

FISH AND WILDLIFE RESOURCE DATA

The vegetative cover, physiographic features, and the size of this watershed restricts fish and wildlife resources to a few species such as birds, rodents, deer, javelina and predators.

WATERSHED PROBLEMS

The principal watershed problem is floodwater and sediment damage to nonagricultural properties. Flood damages occur to residential, commercial, industrial, utilities, highway and street properties. Total average annual flood damages to these properties are estimated to be $777,170. Most floods originating in the Perilla Mountains result from high intensity cloudburst type summer storms. These storms may be centered anywhere in the watershed.

Distressful losses occurred as muddy floodwater rushed from the Perilla Mountains and flowed through the city of Douglas and the community of Pirtleville, Arizona during the storm of July 24, 1957. Future damages from a recurring flood of this magnitude could cost millions in repairs. A flood of this size can be expected to occur on the average of once in 40 years.

Newspaper accounts show the 1957 flood was only one of many which have occurred. Information on eleven major floods and many smaller events have been documented sice the area was settled. Runoff from the July, 1957 event, the key flood studied, caused an estimated $1,385,610 damage to residential, retail-commercial, industrial, and utility properties within the watershed.

FLOODWATER DAMAGE

Floodwater originating in the uplands spread out over the valley area, inundating residential and commercial properties within Douglas and Pirtleville.

In the southern portion of the watershed floodwater flows westward across the city airport and into the residential area of Douglas. The floodwater is channelled by the city streets and concentrates between First and Eighth Streets. Floodwater flows across the cemetery damaging facilities and graves. Houses are inundated, causing damage to furniture, rugs, drapes and household appliances. Floodwater also damages foundations, streets, lawns, and fences. Cesspools are washed out, causing unsanitary conditions and health problems.

Cars forge through floodwater at 5th St.
and Pan American Ave. August 3, 1967
Photo - Courtesy of City of Douglas

Flooding at 6th St. and Pan American Ave.
August 3, 1967
Photo - Courtesy of City of Douglas

The major portion of the floodwater flows into northeast Douglas before draining southwesterly to Whitewater Draw. Floodwater damages homes, the high school, streets, sidewalks, railroad property, the city water system, and the main highways. Floodwater flows through the business district inundating many commercial and retail establishments.

Floodwater from the northern portion of the watershed causes damage to roads, the county fairgrounds, public golf courses, and houses and property in Pirtleville and Douglas.

The 1957 storm caused serious damage to residential areas putting as much as two feet of floodwater in many homes. Several basements were flooded. The walls and foundations of homes cracked. Some adobe homes caved in and were a total loss. One apartment building was condemned following the flood.

Even though many downtown businessmen barricaded their stores with sand bags during the 1957 storm, some were still damaged by floodwater. The high school gymnasium was inundated and the floors seriously damaged.

Traffic on the main highway was stopped. The electrical highline was washed out in one area leaving a large area without electricity. Part of the city's water main system was washed out, leaving another area without water for a week.

Total estimated floodwater damage to residential, retail-commercial, and other nonagricultural facilities as a result of the 1957 storm was $830,620.

S E D I M E N T D A M A G E

Sediment damages in the watershed are extensive. Sediment yield from the upland area is relatively low. However, when the water flows over the low lying areas it picks up silt and sand and redeposits it downstream. Sediment damages occur in the urban areas; sediment is deposited on streets, driveways, lawns, and in homes. Home owners incur high costs in removing sediment and cleaning floors, rugs, drapes, and other household furnishings.

Sediment deposition on city streets and public property must be removed by the city annually, causing considerable

expense. A major expense is the removal of sediment from the underpass on U.S. Highway 80. Removal of sediment takes several days following a major flood.

While not considered entirely a sediment problem, floodwater and sediment deposition in sewers, cesspools, and septic tanks present a serious sanitation problem. The city water supply is furnished by wells, one of which is subject to pollution from floodwater.

The 1957 storm caused an estimated $388,460 in sediment damages to residences, retail-commercial, and other nonagricultural properties.

EROSION DAMAGE

The effects of erosion are most apparent in the Hills and Slopes Resource Units above the proposed flood control structure sites. However, erosion damages occur mainly in the form of floodplain scour in the Valley Units.

Poor range conditions occur in portions of the Slopes Unit and essentially all of the Valley Unit. Soil conditions and urban expansion decrease chances for the successful application of range treatment in these areas. It is doubtful that these lands will be improved much beyond their current condition.

INDIRECT DAMAGES

Indirect damages resulting from floods or the threat of floods are significant because of floodplain development. Indirect damages include cost of flood prevention measures, loss of wages, cost of additional travel caused by road or street closure, cost of added traffic control and loss of business income. Indirect damages resulting from the July 1957 flood, are estimated to be $166,530.

PROJECTS OF OTHER AGENCIES

The International Boundary Commission, the State of Arizona, the County of Cochise, the City of Douglas, the El Paso Natural Gas Company and the Southern Pacific Railroad have tried to solve their flood problems by constructing channels, dikes, diversions and storm sewers. Flood prevention measures and appurtenant works have cost an estimated $90,000 in the last ten years. These structural measures have provided very limited flood protection. The City plans to install an internal surface floodwater drainage system utilizing the proposed Floodway No. 1 as an outlet for the drains. The City plans to depress and pave several unimproved north-south streets. The intercepted internal floodwaters will be diverted to the floodway. This proposal will drain about two-thirds of the present developed area. The drainage system will require several outlets into the floodway. A local storm that centered over the developed area of Douglas in August 1964 indicates the need and importance of this system.

PROJECT FORMULATION

PROJECT OBJECTIVES

The project objectives of the local people are to:

1. Establish land treatment and structural measures which will contribute directly to watershed protection and flood prevention.

2. Reduce floodwater damage and sediment deposition to residences, retail-commercial properties, utilities, roads, and highways. Because of present and projected development of the flood plain in Douglas and Pirtleville, protection from floods of the magnitude expected once in 100 years is essential.

3. Reduce floodplain scour and erosion.

Project formulation, including land treatment and structural measures, was determined after considering various alternatives that would meet the Sponsors' objectives and be within the Soil Conservation Service standards and policies.

LAND TREATMENT MEASURES

The proposed treatment measures in this work plan were based on need, soil capabilities, land use, and the financial capabilities of the operators. The land treatment measures scheduled for the watershed are those that are necessary to improve and maintain a favorable cover condition in the upper watershed. This will reduce erosion and runoff from this area.

STRUCTURAL MEASURES

Structural works of improvement were determined by considering various alternative plans of structural formulation that would provide the desired degree of flood protection and sediment control. Consideration was given to economic, geologic, and topographic factors.

Three alternative plans were considered. The selected alternative consists of two floodwater retarding structures, two floodways, and a diversion. This alternative was selected because it is the least costly structural formulation that would meet the objectives of the sponsors.

The second alternative plan has the same structures as the first plan but required two separate floodways serving as outlets from the two floodwater retarding structures and then joining in one common floodway to Whitewater Draw.

The third alternative plan includes a system of collecting dikes and a channel with sufficient capacity to transport the 100-year flood to Whitewater Draw.

A discussion of the alternative studies is included in the Investigation and Analysis Section of this plan.

WORKS OF IMPROVEMENT TO BE INSTALLED

LAND TREATMENT MEASURES

Land treatment measures outlined in this plan include only those measures and practices which contribute to the program objectives. The selection of these measures represent judgment and experience gained in dealing with local watershed problems.

FEDERAL LAND

The Bureau of Land Management and permittees will continue cooperative agreements for the land treatment program. Individual management plans will continue to be developed for the allotments involved.

NON-FEDERAL LAND

A combination of land treatment measures is expected to be applied on the range areas. These measures will be installed on privately owned lands as well as land leased from the State of Arizona for agricultural purposes. The land treatment measures will provide for the use of the land within its capabilities and treatment in accordance with its need for sustained production.

Technical assistance to the landowners and operators will be provided by the Whitewater Draw Soil Conservation District.

Table 1 shows the estimated cost of land treatment measures to be installed within the four year installation period of the project. Total cost of installing these measures, including the technical assistance cost, is estimated at $18,150.

The following land treatment measures are based on present and projected land use. If the future land use differs appreciably from that expected, alternative land treatment measures, which will accomplish the same purposes, will be installed.

Brush Control

Killing or suppressing brush by mechanical, chemical, biological, or other means on all areas, except cropland and woodland.

Deferred Grazing

Periodically deferring grazing on rangeland for a prescribed time during any growth period of the year.

Pond

A water impoundment made by constructing a dam or embankment, or by excavating a pit or "dugout".

Proper Grazing Use

Grazing rangeland at an intensity that will maintain adequate soil cover and maintain or improve the quantity and quality of desirable vegetation.

Range Seeding

Establishing adapted plants on rangeland or on land converted to range from other uses.

S T R U C T U R A L M E A S U R E S

The floodwater retarding structures, a floodway, and a diversion will be installed above the floodplain area and will release floodwater into a confined channel for safe conveyance to Whitewater Draw. Inlet structures to this channel will be provided for floodwater originating in the uncontrolled area below the structural measures. The two floodwater retarding structures and the diversion will control 64 percent of the watershed area. All structures will provide protection from a flood that will not be equalled or exceeded on the average of more than once in 100 years (100-year flood). Structure locations are shown in Figures 1 and 4. Typical structural plans are shown in Figures 1 (2), 2 (1) and 2 (2). The estimated total installation cost for these structural works is $4,702,260. (See Table 1.)

The foundation for the Floodwater Retarding Structures consist of relatively pervious materials. Portions of these materials show properties that indicate a possibility of excessive settlement following saturation and loading. An earth blanket 200 feet wide and 4,000 feet long will be provided for each structure to reduce seepage.

Floodwater Retarding Structure No. 1

Floodwater Retarding Structure No. 1 will be constructed northeast of Douglas at an estimated installation cost of $877,300. It will have a total storage capacity of 1,640 acre feet, with 1,490 acre feet allocated to floodwater storage and 150 acre feet allocated to a 100-year accumulated sediment storage. The structure will be 2.0 miles long and have a maximum height of 24.0 feet. An earth emergency spillway, 800 feet wide, will be located at the south end of the embankment. The principal spillway will be an ungated 5 feet by 5 feet reinforced concrete box with a SAF Outlet Basin. The maximum release rate from the principal spillway will be 512 c.f.s. Additional structural data are shown in Table 3.

The construction of Floodwater Retarding Structure No. 1 will necessitate the relocation of 1 mile of farm road and the raising of 10 power line poles.

Floodway No. 1

Floodway No. 1 will be 4.7 miles long and will convey the floodwater release from the principal spillway of Floodwater Retarding Structure No. 1 westward to Whitewater Draw. This floodway will be stabilized with rock riprap throughout its length. About four miles of the floodway will be located along existing channels. The floodway channel will have a trapezoidal shape. Typical sections are shown in Figure 2 (1). Concrete box culverts will be constructed at Washington Avenue and "G" Avenue crossings. At the upper crossing of the channel by Highway 80, the existing bridge will be modified by adding an additional span. At the lower crossing of this highway, and at the two crossings of the Southern Pacific Railroad, existing bridges are adequate and no modifications will be required.

The floodway is designed to accommodate the 100-year flood originating in the uncontrolled area below the floodwater re-retarding structures combined with the release rate from Floodwater Retarding Structure No. 1. Drop Spillway Inlets will be constructed at seven locations along the floodway to convey the

uncontrolled area floodwaters safely into the floodway. The capacity of this floodway will vary from 512 c.f.s. to 5,740 c.f.s. The installation cost of this floodway is estimated to be $1,978,660. Additional structural data are shown in Table 3A.

Floodwater Retarding Structure No. 2

Floodwater Retarding Structure No. 2 will be constructed north of Floodwater Retarding Structure No. 1 at an estimated installation cost of $1,167,780. It will have a total storage capacity of 1,708 acre feet with 1,528 acre feet allocated to floodwater storage and 180 acre feet allocated to a 100-year accumulated sediment storage. The structure will be 2.3 miles long and have a maximum height of 29.8 feet. An earth emergency spillway, 900 feet wide, will be located at the north end of the embankment. The ungated 4 feet by 4 feet reinforced concrete principal spillway will discharge into Floodway No. 2. The maximum release rate will be 315 c.f.s.

Additional structural data are shown in Table 3.

To avoid the floodwater retarding pool, the El Paso Natural Gas pipeline will be relocated.

Floodway No. 2

Floodway No. 2 will be 0.4 miles long and will convey the floodwater release from the principal spillway of Floodwater Retarding Structure No. 2 south under U.S. Highway No. 80 to Floodwater Retarding Structure No. 1. This excavated, trapezoidal shaped floodway will be stabilized with rock riprap and will have a capacity of 315 c.f.s. The installation cost of this floodway is estimated to be $43,680. Additional structural data are shown in Table 3A.

Airport Diversion

The Airport Diversion will be constructed at the east boundary of the Douglas City Airport at an estimated installation cost of $296,020. This structure will divert floodwater into Floodwater Retarding Structure No. 1. The diversion will be 1.8 miles long and will have an average channel depth of 2.7 feet. Capacity will vary from 966 c.f.s. to 2,480 c.f.s. A concrete box culvert will be constructed where the diversion crosses Geronimo Trail. Additional structural data are shown in Table 3A.

The diversion will consist of an excavated, trapezoidal shaped earth channel and embankment. Due to a steep gradient, the channel will be stabilized with riprap for 3,800 feet of its length. Typical sections are shown in Figure 2 (2).

EXPLANATION OF INSTALLATION COSTS

LAND TREATMENT MEASURES

The cost of establishing the land treatment measures prescribed in the work plan includes:

1. Physically applying the required measures.

2. Technical assistance.

Land treatment measures on Federal lands have been completed in conformance with the policies and standards of the land administering agency and the Soil Conservation Service. Costs of applying land treatment measures on non-Federal and State leased lands will be borne by individual landowners and operators. The Agricultural Stabilization and Conservation Service may provide cost-sharing assistance on non-Federal and State leased lands.

The quantity-unit cost approach was used to estimate the cost of installing the land treatment measures. Cost estimates for technical assistance were based on similar costs encountered for the existing conservation program in the area. Technical assistance costs to install the land treatment measures will be borne by "going program" funds.

STRUCTURAL MEASURES

The total installation cost for structural measures includes costs of construction; engineering services; project administration; and land rights. A tabulation of installation cost items for each structural measure is included as Table 2 of this plan.

CONSTRUCTION

Construction costs shown in the engineer's estimate were based on local information and recent contract data for P.L. 566 projects in Arizona. The Arizona Highway Department's annual

publication relating to unit bid costs of highway construction items was also used in the preparation of cost estimates. The estimated construction costs include an allowance of 20 percent to provide for contingencies.

ENGINEERING SERVICES

The cost of engineering services include services of engineers, hydrologists and geologists for surveys, site investigations (including stability of earth spillways), soil mechanics, structural designs, flood routings, construction plans and specifications for structural measures. Engineering costs are estimated at 20 percent of construction costs.

PROJECT ADMINISTRATION

The cost of project administration are the P.L. 566 and other administration costs associated with the installation of structural measures including the cost of contract administration, review of engineering plans prepared by others, government representatives, construction surveys, and necessary inspection service during construction to insure that structural measures are installed in accordance with the plans and specifications. Project administration costs for P.L. 566 and other funds are estimated at ten and one percent of the construction cost, respectively.

LAND RIGHTS

Land rights include costs for land acquisition, all relocations of utilities and roads including elements of work involving construction and engineering services directly associated with land rights. Land rights costs were determined through meetings with the sponsoring local organizations and concurred in by the Soil Conservation Service. The major land rights costs are those for land acquisition, estimated at $351,950. However, this does not preclude the possibility of the purchase or donation of flowage easements in lieu of direct land purchases. Relocations and changes of utilities and roads include one gas line relocation estimated at $115,550; one power line crossing estimated at $2,750; one road relocation estimated at $5,500; and four road crossings estimated at $191,420.

COST SHARING

Installation costs will be shared by the local sponsoring organizations and the Federal government in accordance with the requirements of Public Law 566, as amended, and the Secretary's Policy Statement.

The total installation cost of the project is estimated at $4,720,410 of which $4,004,290 are from P.L. 566 funds and $716,120 are from other funds.

P.L. 566 Funds will bear:

1. The construction cost of the structural measures for flood prevention. (Estimated cost $3,080,220).

2. The cost of the engineering services of all structural measures. (Estimated cost $616,050).

3. Project administration costs incurred by the Federal Government. (Estimated cost $308,020).

Other Funds will bear:

1. The cost of installing land treatment measures on non-Federal land. (Estimated cost $12,200).

2. Cost of technical assistance for the existing land treatment program on non-Federal land. (Estimated cost $5,950).

3. Project administration cost incurred by the Sponsors. (Estimated cost $30,800).

4. Total cost of land rights for the structural measures. (Estimated cost $667,170).

EXPECTED EXPENDITURES OF FUNDS BY FISCAL YEARS

Perilla Mountain Watershed, Arizona
(Dollars)

	FISCAL YEARS				
	1	2	3	4	Total
P.L. 566 Funds					
Construction		788,620	1,482,800	808,800	3,080,220
Engineering Services	157,730	296,560	161,760		616,050
Project Administration		78,860	148,280	80,880	308,020
Total-P.L. 566 Funds	157,730	1,164,040	1,792,840	889,680	4,004,290
Other Funds					
Land Treatment					
SCS-Rangeland		7,000	5,000	200	12,200
-Technical Assistance	3,500	2,160	220	70	5,950
Project Administration		7,890	14,830	8,080	30,800
Land Rights	426,270	240,900			667,170
Total-Other Funds	429,770	257,950	20,050	8,350	716,120
TOTAL	587,500	1,421,990	1,812,890	898,030	4,720,410

EFFECTS OF WORKS OF IMPROVEMENT

The works of improvement proposed in this plan will substantially reduce floodwater and sediment damages within the watershed. Installation of the proposed land treatment measures will increase cover and improve infiltration and range conditions. These measures will have a minor effect on the reduction of damage downstream. Installation of the structural measures will control and reduce the runoff from 64 percent of the total watershed area. These structures will reduce the peak flows and substantially reduce the areas subject to flooding.

The works of improvement will benefit approximately 4,160 acres and will protect many residential and retail-commercial properties within Douglas and Pirtleville, reducing the average annual damages by about 76 percent. Floodway No. 1 will prevent the floodwater originating below the structural measures from overflowing the present channel banks and inundating portions of Douglas and Pirtleville. Residual damages will continue to occur primarily in the southern portion of Douglas. The City of Douglas plans to construct a floodwater drainage system to control this local runoff.

If the proposed works of improvement had been installed at the time of the 1957 storm, total damages would have been reduced by an estimated $1,088,000. Floodwater damages would have been reduced approximately $612,000, sediment damages $320,000, and indirect damages $156,000.

An aerial mosaic map (Figure 5) showing the areas flooded by a 100-year event with and without the project demonstrates the effectiveness of the proposed structures. Without the project, approximately 4,700 acres would be flooded. With the project measures installed, the flooded area would be reduced to only 560 acres.

There are over 4,200 homes located in the floodplain area. The total estimated value of these homes is in excess of $34,000,000. The reduction of frequent flooding of streets, homes, and businesses is an essential part of the local residents' goal to develop and maintain a prosperous economy.

PROJECT BENEFITS

Total flood prevention benefits accruing to project structural measures are estimated to be $585,030 annually. Of this amount, $328,870 will result from reduction in floodwater damages and $173,200 are benefits from reduction in sediment damages. Indirect damage reduction benefits are estimated to be $82,960 annually.

Benefits that will accrue outside the project boundaries were not evaluated.

The value of secondary benefits from a national viewpoint was not considered in the economic evaluation or justification of this project.

COMPARISON OF BENEFITS AND COSTS

The structural measures described in this work plan are economically feasible. The total average annual benefits to accrue from the installation of the proposed structural measures are $585,030. The average annual cost of installing the structural works is estimated to be $214,550 and cost of operation and maintenance is estimated to be $22,170 annually. The total average annual cost is estimated to be $253,380. The ratio of average annual benefits to average annual cost is 2.3 to 1.0. Secondary benefits were not evaluated.

PROJECT INSTALLATION

Execution of this work plan will be a joint undertaking of Non-Federal and Federal interests. Non-Federal interests include ranchers, the City of Douglas, Cochise County, State of Arizona, and the Whitewater Draw Soil Conservation District. Federal interests include the Bureau of Land Management of the U.S. Department of the Interior and the Agricultural Stabilization and Conservation Service and the Soil Conservation Service of the U.S. Department of Agriculture.

In order to coordinate installation of the land treatment and structural measures provided for in this plan, close cooperation and specific responsibilities are required of the Non-Federal and Federal interests involved. The Whitewater Draw Soil Conservation District and the City of Douglas will have the primary responsibility for accomplishing the plan.

The City of Douglas will:

1. Carry out and assume responsibility and all liability for the construction, operation, and maintenance of structural measures.

2. Acquire all land and water rights needed in connection with the works of improvement. The power of eminent domain will be exercised if necessary.

3. Act as contracting organization for the construction of all structural measures.

The Whitewater Draw Soil Conservation District will:

1. Provide technical assistance to landowners and operators in the District to assure the application of land treatment measures outlined in the plan.

2. Conduct an information and education program to properly inform local people of the project.

The Bureau of Land Management will:

1. Continue its management program on land which it administers.

The Agricultural Stabilization and Conservation Service will:

Provide Federal cost-sharing assistance in accordance with existing Agricultural Stabilization and Conservation Service policies and procedures to individual ranchers in applying approved conservation practices on their ranches.

The Soil Conservation Service will:

1. Furnish technical assistance through the Whitewater Draw Soil Conservation District to the private landowners for the application of land treatment measures outlined in this work plan.

2. Furnish installation services for engineering surveys, design, land rights work map, construction plans and specifications for structural works of improvement for flood prevention and inspection during construction.

3. Allot P.L. 566 construction funds in accordance with cost sharing and the installation schedule as outlined in this plan or as may be revised by mutual agreement. Allocation of funds will be in accordance with National priorities and the availability at the time of installation.

4. Maintain liaison with sponsors, State and Federal agencies involved so that the objectives outlined in this plan will be accomplished for the benefit of all concerned.

A four year installation period is planned for the project. The land treatment measures will be applied throughout the installation period.

During the first year, all land rights will be secured for Floodwater Retarding Structure (FRS) No. 1, Airport Diversion, and Floodway No. 1. All necessary surveys, investigations and detailed designs will be completed for FRS No. 1 and the Airport Diversion. Installation of land treatment measures will begin.

During the second year, FRS No. 1 and the Airport Diversion will be constructed. Land rights will be secured for FRS No. 2. All necessary surveys, investigations and detailed designs will be completed for Floodway No. 1. Installation of land treatment measures will continue.

Floodway No. 1 will be constructed during the third year. Final designs for FRS No. 2 and Floodway No. 2 will be completed.

FRS No. 2 and Floodway No. 2 will be constructed during the fourth year. Installation of all structural and land treatment measures will be completed.

FINANCING PROJECT INSTALLATION

Project installation costs allotted to P.L. 566 will be paid from funds appropriated under the authority of P.L. 566, 83d Congress, 68 Stat. 666 as amended. This work plan does not constitute a financial document for obligation of Federal and other funds. Financial or other assistance to be furnished by the Service in carrying out the plan is contingent on the appropriation of funds for this purpose.

The cost of installing land treatment measures will be borne by the individual landowners or operators with such financial assistance as may be available from the Agricultural Conservation Program.

The Soil Conservation Service will continue to provide technical assistance at the present rate under the going program.

Costs for the installation of structural measures to be borne by other than P.L. 566 funds will be the responsibility of the City of Douglas. The City of Douglas has special state authority under Section 45-2335 of the Flood Control Law, (Chapter 10, Arizona Revised Statutes - Annotated Laws 1958, Second Regular Session - Twenty-third Legislature), to acquire property by eminent domain, levy taxes, and issue bonds. The City will exercise its powers as necessary to secure land rights.

The City has analyzed its financial needs in consideration of the scheduled installation of the works of improvement so that funds will be available when needed.

PROVISIONS FOR

OPERATION AND MAINTENANCE

LAND TREATMENT MEASURES

Ranchers cooperating with the Whitewater Draw Soil Conservation District will be responsible for the maintenance of land treatment measures installed on their ranches including state leases.

Land treatment measures on Federal lands will be maintained by the Bureau of Land Management.

STRUCTURAL MEASURES

The City of Douglas will operate and maintain all structural works of improvement after they are installed. The City will obtain necessary funds for operation, maintenance and replacement from tax or assessment levies.

For a period of three years following installation of each structural measure, a designated employee of the Soil Conservation Service and a Sponsor's representative will make a joint annual inspection. Annual inspections following the third year will be made by the Sponsors and a report will be sent to the designated Soil Conservation Service representative. Inspections including a report will also be made after floods or after the occurrence of any situation which might adversely affect the operation of any of the structural measures.

Operation and maintenance agreements will be entered into between the Sponsors and the Service prior to the issuance of invitation to bid.

Total annual operation, maintenance and replacement cost of structural measures is estimated to be $22,170.

It is agreed that representatives of the Federal, State, and County governments shall have free access at all times to the structural works of improvement for official activities.

All phases of operation and maintenance of these facilities shall comply with applicable local, State, and Federal regulations.

Those items considered necessary for the proper operation and maintenance of the structural works of improvement shall include but are not limited to the following:

O P E R A T I O N

The structural measures for flood prevention are automatic in operation. The ungated principal spillways will allow floodwaters to discharge into the floodways as soon as it enters the reservoir areas.

M A I N T E N A N C E

1. All structures are to be maintained by making repairs or replacements as needed.

2. Obstructions, trash, and debris are to be removed from the principal spillway inlet and the floodways.

3. Repairs to structures or structural features damaged by floods will be made promptly.

4. A drainage gradient through the reservoir basin will be maintained so that no local ponding areas are formed.

5. Sediment deposits and weeds are to be removed from the diversion channel to maintain its capacity for floodwaters.

6. Faces of earth embankments are to be graded as needed to prevent the concentration of runoff from eroding embankment side slopes.

TABLE 1 - ESTIMATED PROJECT INSTALLATION COST

Perilla Mountain Watershed, Arizona

Installation Cost Item	Unit	Number	Estimated Cost (Dollars) 1/ Non-Federal Land P.L. 566	Other	Total
LAND TREATMENT					
Soil Conservation Service					
Rangeland	ac.	12,000		12,200	12,200
Technical Assistance				5,950	5,950
TOTAL LAND TREATMENT				18,150	18,150
STRUCTURAL MEASURES					
Soil Conservation Service					
Flood Retarding Structures	no.	2	1,354,940		1,354,940
Floodways	no.	2	1,519,200		1,519,200
Diversion	no.	1	206,080		206,080
Subtotal - Construction			3,080,220		3,080,220
Engineering Services					
Soil Conservation Service			616,050		616,050
Subtotal - Engineering Services			616,050		616,050
Project Administration					
Soil Conservation Service					
Construction Inspection			184,810		184,810
Other			123,210	30,800	154,010
Subtotal - Project Administration			308,020	30,800	338,820
Other Costs					
Land Rights				667,170	667,170
Subtotal - Other Costs				667,170	667,170
TOTAL STRUCTURAL MEASURES			4,004,290	697,970	4,702,260
TOTAL PROJECT			4,004,290	716,120	4,720,410

1/ Price base 1969 prices

April 1970

TABLE 1A - STATUS OF WATERSHED WORKS OF IMPROVEMENT
(At time of work plan preparation)

Perilla Mountain Watershed, Arizona

Measures	Unit	Applied To Date	Total Cost (Dollars) 1/
LAND TREATMENT			
Non-Federal Land			
Brush Control	ac.	3	80
Deferred Grazing	ac.	7,000	700
Pipeline	ft.	20,300	12,180
Pond	no.	5	10,000
Proper Grazing Use	ac.	7,000	700
Stock Trail	ft.	7,900	1,980
Trough or Tank	no.	4	8,000
Subtotal			33,590
STRUCTURAL MEASURES			
City Construction and Maintenance			25,000
Arizona Highway Department Drainage Ditch			50,000
Southern Pacific Railroad Dikes and Channel Clearing			15,000
Subtotal			90,000
TOTAL			123,590

1/ Price base 1969 prices

April 1970

TABLE 2 - ESTIMATED STRUCTURAL COST DISTRIBUTION

Perilla Mountain Watershed, Arizona
(Dollars) 1/

Item	Installation Cost P.L. 566 Funds			Installation Cost Other Funds		Total Instal. Cost
	Con-struction	Engi-neering	Rights	Total P.L. 566	Total Other	
Floodwater Retarding Structures						
No. 1	582,540	116,510	178,250 2/	699,050	178,250	877,300
No. 2	772,400	154,480	240,900 3/	926,880	240,900	1,167,780
Floodways						
No. 1	1,482,800	296,560	199,300 4/	1,779,360	199,300	1,978,660
No. 2	36,400	7,280		43,680		43,680
Airport Diversion	206,080	41,220	48,720 5/	247,300	48,720	296,020
Subtotal	3,080,220	616,050	667,170	3,696,270	667,170	4,363,440
Project Administration				308,020	30,800	338,820
GRAND TOTAL	3,080,220	616,050	667,170	4,004,290	697,970	4,702,260

1/ Price base 1969 prices.
2/ Includes $2,750 for raising of powerline and $5,500 for farm road relocation.
3/ Includes $115,550 for gas line relocation.
4/ Includes $41,140 for modification to U.S. Highway 80 bridge, $61,330 for construction of "G" Avenue crossing and $55,830 for construction of Washington Avenue crossing.
5/ Includes $33,120 for construction of Geronimo Trail crossing.

April 1970

TABLE 3 - STRUCTURAL DATA
FLOODWATER RETARDING STRUCTURES
Perilla Mountain Watershed, Arizona

ITEM	UNIT	No. 1	No. 2	TOTAL
Class of Structure		c	c	
Drainage Area	Sq. Mi.	14.8	18.0	32.8
Curve No. (1-day) (AMC II)		86	86	
Tc	Hrs.	0.85	1.26	
Elevation Top of Dam	Ft.	4126.0	4148.0	
Elevation Crest Emergency Spillway	Ft.	4119.0	4140.0	
Elevation Crest Riser Inlet	Ft.	4105.6	4130.0	
Maximum Height of Dam	Ft.	24.0	29.8	
Volume of Fill	Cu. Yds.	671,800	862,200	1,534,000
Total Capacity	Ac. Ft.	1640	1708	3348
Sediment Storage 100 years	Ac. Ft.	150	180	330
Retarding	Ac. Ft.	1490	1528	3018
Surface Area				
Retarding Pool	Acres	234	245	479
Principal Spillway				
Rainfall Volume (areal) (1 day)	In.	3.28	3.28	
Rainfall Volume (areal) (10 day)	In.	6.27	6.27	
Runoff Volume (10 day)	In.	4.66	4.66	
Capacity at Emer. Spillway Elev.	cfs.	512	315	
Frequency Operation - Emer. Spillway	% Chance	1	1	
Size of Conduit	Ft. x Ft.	5 x 5	4 x 4	
Emergency Spillway				
Rainfall Volume (ESH) (areal)	In.	7.67	7.43	
Runoff Volume (ESH)	In.	6.00	5.77	
Type		Earth	Earth	
Bottom Width	Ft.	800	900	
Velocity of Flow (V_e)	Ft./Sec.	5.35	4.00	
Slope of Exit Channel	Ft./Ft.	.005	.002	
Maximum Water Surface Elevation	Ft.	4121.9	4143.4	
Freeboard				
Rainfall Volume (FH) (areal)	In.	18.8	18.2	
Runoff Volume (FH)	In.	16.98	16.38	
Maximum Water Surface Elevation	Ft.	4125.8	4147.8	
Capacity Equivalents				
Sediment Volume	In.	0.23	0.15	
Retarding Volume	In.	1.89	1.59	

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TABLE 3A - STRUCTURE DATA

FLOODWAY STABILIZATION

Perilla Mountain Watershed, Arizona

Channel Designation	Stations or Reach		Drainage Area Sq. Mi.	Capacity cfs Design	Water Surface Elev. [1]	Hydraulic Gradient (Ft/Ft)	Average Channel Dimensions Bottom(Ft)	Depth(Ft)	"n" Values [2] Aged	As Built	Average Velocities [3] Ft/Sec Aged	As Built	Volumes of Excavation Cu. Yds.	Riprap Cu. Yds.	Concrete Cu. Yds.	Type of Channol Improvement
Floodway #1		7+70	Begin Floodway at FRS #1			Discharge from FRS #1 = 512 cfs										
	7+70	8+62	0.00	512	5000.40	.01100	5	6.0	.035		6.4		1,400	300		Riprap
	8+62	38+50	0.00		4067.20	.01100	4	5.5	.035		7.7		17,650	8,020		Riprap
	38+50	38+94	0.00	512	4065.55	.03900	8	5.0			7.9		260		56	Concrete
Inlet	℄ @	39+12	1.11	Inlet for side drainage. Local inflow = 658 cfs.												
Transition	38+94	39+30	1.11		4064.20	.03900	16	5.2	.013				210		134	Concrete
	39+30	59+24	1.11	1,170	4041.30	.01150	20	5.3	.035		8.6		24,320	7,820		Riprap
	59+24	61+94	1.11	1,170	4038.80	.01075	47	6.2	.035		7.8		6,770	1,770		Riprop
Inlet	℄ @	62+56	3.70	Inlet for side drainage. Local inflow = 2260 cfs.												
Transition	61+94	63+24	3.70		4037.80	.01075	87	6.6	.035		6.5		4,830	730	240	Riprap
Wash, Ave.	63+24	63+90	3.70	3,430	4037.80	Washington Avenue install 9 - 2x6 concrete for culverts							2,490		344	C.B.C. [4]
	63+90	89+74	3.70	3,430	4030.60	.00280	100	6.1	.035		6.0		72,910	6,600		Riprap
Inlet	℄ @	89+87	4.21	Inlet for side drainage. Local inflows = 330 cfs.												
Transition	89+74	90+00	4.21	3,600	4029.10	.06900	75	6.5			8.4		260		141	Concrete
	90+00	115+60	4.21	3,760	4004.65	.01000	50	7.7	.035		10.7		17,650	19,480		Riprap
Inlet	℄ @	115+90	5.07	Inlet for side drainage. Local inflow = 630 cfs.												
	115+60	116+20	5.07		4004.25	.02800	50	8.0	.013		8.0		740		272	Concrete
Highway 80	116+20	116+80	5.07	4,390	4003.50	Highway #80 bridge (modified from 3 - 20' spans to 24' spans).									324	Concrete
	116+80	120+58	5.07	4,390	3997.80	.01770	40	7.5	.035		13.1		4,170	5,110		Riprap
	120+58	121+10	5.07	4,390	3998.00	.01770	40	10.7	.013		7.9		600		68	Concrete
R.R. Bridge	121+10	121+60	5.07	4,390	3996.20	Southern Pacific Railroad Bridge (to remain).										
	121+60	129+25	5.07	4,390	3993.10	.00400	50	9.1	.035		8.6		4,430	3,510		Riprap
Inlet	℄ @	129+50	6.29	Inlet for side drainage. Local inflow = 570 cfs.												
	129+25	129+75	6.29		3991.60	.01000	50	9.8	.035		10.7		460	390		Riprap
	129+75	148+26	6.29	4,960	3977.65	.00920	50	9.3	.035		11.0		44,500	18,030		
"G" Ave.	148+26	148+60	6.29		3977.00	"G" Avenue - Remove and replace by 7 - 10x10 Concrete Box Culverts.									424	C.B.C. [4]
	148+60	164+50	6.29	4,960	3962.60	.08700	50	9.9	.035		8.4		50,820	12,720		Riprap
Inlet	℄ @	164+75	6.58	Inlet for side drainage. Local inflow + 200 cfs.												
Transition	164+50	165+00	6.58	5,060	3963.00	.01400	55	8.9					1,840	540		Riprap
	165+00	184+30	6.58	5,160	3957.20		60	9.6	.035		7.9		30,920	9,200		Riprap
Highway 80	184+30	184+66	6.58		3957.20	Highway #80 Bridge (to remain).								730		Riprap
	184+66	189+25	6.58	5,160	3953.40	.01330	50	11.2	.035		8.9		3,020	8,980		Riprap
R.R. Bridge	189+25	189+55	6.58		3953.40	Southern Pacific Railroad Bridge (to remain).							500	710		Riprap
	189+55	231+38	6.58	5,160	3921.60	.00700	30	10.7	.035		11.0		24,250	37,740		Riprap
Inlet	℄ @	231+63	7.62	Inlet for side drainage. Local inflow = 580 cfs.												
Transition	231+38	231+88	7.62	5,450	3908.30	.02000	32.5	10.7	.013				830		245	Concrete
	231+88	258+00	7.62	5,740	3908.20	.08500	35	11.4	.035		10.2		33,090	19,090		Riprap

TABLE 3A - STRUCTURE DATA
(Continued)

Channel Designation	Stations or Reach		Drainage Area Sq. Mi.	Capacity cfs Design	Water Surface Elev. 1/	Hydraulic Gradient (Ft/Ft)	Average Channel Dimensions Bottom(Ft)	(Depth(Ft)	"n" Values 2/ Aged	As Built	Average Velocities 3/ Ft/Sec Aged	As Built	Volumes of Excavation Cu. Yds.	Riprap Cu. Yds.	Concrete Cu. Yds.	Type of Channel Improvement
Floodway #2		0+00	Begin Floodway at FRS #2.			Discharge from FRS #2 = 315 cfs.										
	0+00	20+20	0.0	315	4107.8	.00584	6.0	5.5		.035		6.1	15,600	3,420		Riprap
Airport	0+00	14+00	0.66	960	4178.90	.00200	200	3.6	.030	.020	3.0	3.8	10,250		2,980	Earth
Diversion	14+00	17+30	0.66	966	4178.20	.00300	175	3.8	.030	.020	3.2	4.6	4,310		340	Earth
	17+30	30+80	0.66	966	4175.50	.00200	150	3.9	.030	.020	3.3	4.2	18,920		950	Earth
	30+80	38+55	0.66	966	4167.90	.01250	82.5	6.0		.035		6.3	9,640	4,016	1,120	Riprap
	38+55	62+90	0.66	966	4138.40	.01250	15	6.0		.035		9.0	12,310	10,095	4,970	Riprap
Geronimo Tr.	62+90	63+70	0.66	966	4138.40	.00000	Geronimo Trail - Install 4 - 8x6 Concrete Box Culverts at 45° skew.									C.B.C. 4/
	63+70	68+80	0.66	966	4131.10	.00900	70	6.9		.035		4.9	10,990	2,134		Riprap
	(68+80	76+80)	2.04	Side drainage enters. Local inflow = 1514 cfs.												
Transition	68+80	76+80	2.04	1720	4128.30	.00350	200	4.2	.030	.020	3.5	4.8	40,230			Earth
	76+80	95+80	2.04	2480	4124.50	.00200	280	4.2	.030	.020	3.5	4.8	60,000m		590	Earth

Design Storm Frequency: 1%

Side Slopes: Floodway No. 1: 3 Hor.: 1 Vert.
Floodway No. 2: 1½ Hor.: 1 Vert.
Airport Diversion: 3 Hor.: 1 Vert.

1/ Elevations shown represent Water Surface Elevation for downstream station in particular reach.
2/ For all reaches that are riprapped or concrete lined, Aged "n" Values are identical to As Built "n" Values.
3/ For all reaches that are riprapped or concrete lined, Aged Velocities are identical to As Built Velocities.
4/ C.B.C. means "Concrete Box Culverts".

TABLE 4 - ANNUAL COSTS

Perilla Mountain Watershed, Arizona
(Dollars) 1/

Evaluation Unit	Amortization of Installation Cost 2/	Operation and Maintenance Cost	Total
Floodwater, Retarding Structure, Floodways, and Diversion	214,550	22,170	236,720
Project Administration	16,660		16,660
GRAND TOTAL	231,210	22,170	253,380

1/ Price base: Installation - 1969 Prices, O&M - Adjusted Normalized Prices.

2/ 100 Years @ 4-7/8 percent interest.

April 1970

TABLE 5 - ESTIMATED AVERAGE ANNUAL FLOOD DAMAGE REDUCTION BENEFITS

Perilla Mountain Watershed, Arizona

(Dollars) 1/

Item	Estimated Average Annual Damage Without Project	With Project	Damage Reduction Benefit
Floodwater			
Non-Agriculture			
Residential	278,650	82,580	196,070
Commercial & Industrial	165,400	39,180	126,220
Other (Utilities, State and County)	11,470	3,240	8,230
Subtotal	455,520	125,000	330,520
Sediment			
Non-Agricultural			
Residential	192,630	32,230	160,420
Commercial & Industrial	10,260	3,620	6,640
Other	8,640	1,630	7,010
Subtotal	211,550	37,480	174,070
Indirect	110,100	26,720	83,380
TOTAL	777,170	189,200	587,970

1/ Adjusted Normalized Price Base

April 1970

TABLE 6 - COMPARISON OF BENEFITS AND COSTS FOR STRUCTURAL MEASURES

Perilla Mountain Watershed, Arizona

(Dollars) 1/

Evaluation Unit	Average Annual Benefits Flood Prevention Damage Reduction	Average Annual Cost	Benefit Cost Ratio
Floodwater Retarding Structures, Floodways, and Diversion	585,030 2/	236,720	2.5:1.0
Project Administration		16,660	
GRAND TOTAL	585,030	253,380	2.3:1.0

1/ Price base: Benefits - Adjusted Normalized Prices
Costs - 1969 Prices

2/ In addition it is estimated that land treatment measures will provide flood damage reduction benefits of $2,940 annually.

April 1970

INVESTIGATION AND ANALYSES SECTION

PERILLA MOUNTAIN WATERSHED

Cochise County, Arizona

L A N D U S E A N D T R E A T M E N T

H Y D R O L O G I C I N V E S T I G A T I O N S

G E O L O G I C I N V E S T I G A T I O N S

S E D I M E N T A T I O N I N V E S T I G A T I O N

E N G I N E E R I N G I N V E S T I G A T I O N S

E C O N O M I C I N V E S T I G A T I O N S

F I S H A N D W I L D L I F E I N V E S T I G A T I O N S

April 1970

LAND USE AND TREATMENT

Land treatment measures to be applied by ranchers cooperating with the Whitewater Draw Soil Conservation District are part of this watershed work plan. These measures were based on soil surveys, technical guide data, and past accomplishments of the regular going program of the Soil Conservation District and the Agricultural Stabilization and Conservation Service.

Cost of technical assistance for installation of the land treatment measures was based on the average work performance time for each of the individual measures to be applied. An average hourly rate was established to fit local conditions using Advisory Notice B&F Arizona 10, dated September 22, 1969, as a guide.

The unit costs of establishing the land treatment measures outlined in this plan were obtained by checking actual cost records in the area under the going program of the Soil Conservation District and the Agricultural Stabilization and Conservation Service program of cost-sharing. These costs were used in computing the unit costs of the land treatment program in the project. They were also compared to cost data for similar agricultural areas in the state.

Costs of applying the land treatment measures were derived on the basis of the going program and those measures needed to accomplish the objectives of the local sponsors. The landowners on whose property these measures are to be applied will bear the cost of application.

HYDROLOGIC INVESTIGATIONS

Hydrologic investigations were made to determine the peak flow and run-off volume characteristics, structural design hydrographs, and peak flow-frequency relationships for economic analyses.

B A S I C D A T A

There are no stream gauging stations located in the watershed. Whitewater Draw, of which Perilla Mountain Watershed is a tributary, has 34 full years of records. The confluence of the major waterway from the watershed and Whitewater Draw is below the gaging station. Due to the difference in the watershed's size (654,720 acres vs 32,585 acres) and other characteristics, the gaged records do not agree with the Perilla Mountain Watershed historical flood information. There is also a six year record of runoff on the upper 40 square miles of Whitewater Draw. Since 1953, the Agricultural Research Service has been making an intensive runoff study on the Walnut Gulch Watershed some 40 miles to the northwest. Because of the short periods of record, runoff data from the latter two watersheds was used for comparison only.

Fifty-nine years of daily precipitation records and 19 years of hourly precipitation records have been collected in Douglas. The Bisbee Weather Bureau station with 76 years of records is located within 24 miles of the watershed. These stations provide the best precipitation data available.

Frequency analyses were made for the 2-hour, 1, 2, 3 and 10 day amounts of precipitation for Douglas and Bisbee Weather Bureau stations. Two hour precipitation amounts agreed closely with U.S. Weather Bureau revised TP-40 values. Revised TP-40 precipitation amounts were used for the 2-hour duration and Douglas Station precipitation data were used for durations of one day and greater.

Reliable records of high water marks were available for three recent floods at the U.S. Highway 80 bridge and railroad trestle. From these marks and from information furnished by

local residents, estimates of peak flows, volumes of runoff and frequencies of historical events were made. These values agreed closely with peak rates of runoff estimated from precipitation for comparable frequencies.

A range site and condition map was available for all land in the watershed, except the urban areas. Hydrologic soil groupings were available for the entire watershed. Run-off curve numbers were computed using procedures outlined in the Chapters (Ch.) 7, 8, and 9, National Engineering Handbook (NEH), Sect. 4.

Times of concentration were derived from stream channel hydraulics. Channel cross-sections and profiles were surveyed on the major washes. Procedures outlined in Ch. 15, Sect. 4, NEH were used.

Local precipitation data was used for structure design. Peak rates of run-off were computed by the methods outlined in Ch. 16, Sect. 4, NEH.

S T R U C T U R E D E S I G N

Floodwater detention storage was based on the estimated runoff from a 100-year frequency 10-day storm following the principles outlined in Technical Release No. 10. Subsequent checks by the procedures of Ch. 21, Sect. 4, NEH indicated that the proposed detention storage exceeds current minimum standards. Flood routing for the floodwater retarding dams was accomplished using the convex method described in Ch. 17, Sect. 4, NEH.

Emergency spillway and freeboard hydrographs were computed using criteria established in Engineering Memorandum SCS-27 (Rev. 2) and the techniques described in Ch. 21, Sect. 4, NEH.

Peak rates of runoff were computed for the Airport Diversion and Floodway No. 1 using the methods outlined in Ch. 16, Sect. 4, NEH. Hydrographs for individual areas were combined in a time lag routing procedure down Floodway No. 1.

Flood channel along side of International Ave.
SCS PHOTO 2-792-1

Sediment ladened floodwater rushing down
International Ave. July 29, 1964.
Photo - Courtesy of City of Douglas

AREA INUNDATED FREQUENCY ANALYSIS

Frequency curves of runoff volume and peak discharge were developed for the 1, 2, 5, 10, 25 and 50 percent chance of occurrence storms based on rainfall record analyses.

The peak discharge for the 1957 storm was determined from hydraulic computations based on high water marks observed in the field. The peak discharge curve was used to determine the frequency of the 1957 storm. Local interviews regarding past floods indicate the assigned frequency to be reasonable.

Areas inundated were determined for the 1957 flood by interviews and field reconnaissance surveys. Areas inundated were projected to other storm frequencies on the basis that the areas inundated are proportional to the volume of runoff from a 2-hour duration storm. Interviews indicated that damages will begin between the one and two year storm event.

The basic points used in developing area inundated versus frequency curves were the area inundated and the associated frequency for the flood of 1957 and at the point where flooding begins.

GEOLOGIC INVESTIGATIONS

Preliminary investigations were made to determine the feasibility of two floodwater retarding structure sites and the diversion site. The investigations included analyses of test pit logs and surface studies of watershed slopes, channel banks, and rock outcrops.

Floodwater Retarding Structure No. 1

Test pits were dug along the centerline of the dam and in the borrow and emergency spillway areas. Soil samples were taken of representative materials found at the site for design consideration.

Foundation conditions vary considerably at the site. The south abutment section is underlain by highly permeable cinders and fractured basalt. The center section is underlain by silt-layers of sandy clayey silt. The north end is underlain by interbedded layers of sandy silty clay, sandy clayey silt, and stratified clayey sandy gravel.

A wide variety of borrow materials are available at the site. Materials range from well graded sandy gravels to sandy clays and silts. Basalt boulders were found at shallow depths near the south abutment and lithified siltstone was encountered at varying depths upstream from the center section of the dam.

A shallow overburden of clayey silt and sandy clay was found over basalt boulders and bedrock in a portion of the emergency spillway area.

The structure site is geologically feasible; however, proper design and construction will be necessary to overcome foundation deficiencies. Since a positive cutoff appears impractical, foundation design should include features to insure against excessive seepage in the south abutment section of the dam.

Sufficient quantities of suitable borrow materials are available at the site. Borrow depth may be limited in some areas due to the shallow occurrence of basalt or siltstone.

Rock excavation will be necessary to bring the emergency spillway to planned grades.

Floodwater Retarding Structure No. 2

Representative soil samples were obtained from the centerline and emergency spillway test pits for correlation of materials.

Interbedded layers of various types of materials were found along the centerline of the dam. Foundation materials at the north end of the dam consist of silty sands and sandy clays overlying permeable sands and gravels containing lenses of sandy clay. Interbedded layers of sandy clays and silts and silty to clayey sands and gravels underlie the remainder of the dam. Numerous dry weather cracks have developed in the more plastic surface soils found in the swale areas traversed by the centerline of the dam.

Borrow materials were considered similar to those found along the centerline of the dam.

Silty and sandy gravel with a thin mantle of sandy clay material was found in the emergency spillway area.

The dam site is geologically feasible. Foundation materials encountered during the investigation appear competent to support the loads to be imposed. A positive cutoff appears impractical due to the presence of permeable sand and gravel layers. The depth of the cutoff trench should be below the zones of desiccation cracking. Control of seepage in the north abutment may be necessary. These problems can be overcome by proper design and construction.

Sufficient quantities of borrow materials are available upstream from the dam site. Material excavated from the emergency spillway is suitable for embankment fill.

Airport Diversion

Hand auger borings and visual inspection of outcrops were made at the diversion site to determine geologic feasibility.

Sandy materials overlying shallow occurrences of caliche appear to be present in the foundation. The sandy surface soils may serve as embankment fill materials.

Foundation materials appear competent to support the loads to be imposed. Sufficient quantities of borrow materials are available at the site for construction of the diversion embankment.

FLOODWAY STABILITY

Floodway No. 1

Seven pits were dug along the upper portion of Floodway No. 1 to evaluate the soil stability. The lower portion of the floodway was investigated by inspecting the channel banks and the bedload material. Low plasticity silts and clays with layers of sand and gravel were found along the floodway.

Floodway slopes vary from 0.0028 to 0.069 ft./ft. Design velocities range from 6.0 to 14.4 ft./sec. It was determined that with these slopes and velocities the soils in the floodway would not be stable. Lining this floodway with suitable material is recommended.

Floodway No. 2

Visual inspection and correlation of test pits were used to evaluate the stability of Floodway No. 2. Sandy silts, clays, and clayey sands are present in the floodway.

Average slope of the floodway is 0.0058 ft./ft. and the design velocity is 6.1 ft./sec. At this slope and velocity the floodway will be unstable unless protected.

Airport Diversion

Five hand auger borings were dug along or within close proximity to the centerline of the diversion. The remainder of the diversion was investigated by inspection of surface materials and outcrops along road cuts and existing diversion channels in the area. Shallow sandy surface soils generally overlie caliche along the centerline of the diversion channel.

The slopes of the diversion channel from Station 0+00 to 30+80 is 0.002 ft./ft. Design velocities in this section range from 3.0 to 3.3 ft./sec. Caliche materials at grade in the channel are expected to remain fairly stable at these velocities; therefore, this section may remain unlined.

A slope of 0.0125 ft./ft. and design velocity of 9.0 ft./sec. are planned from Station 30+80 to 62+90. A slope of 0.009 ft./ft. and design velocity of 4.9 ft./sec. are planned from Station 63+70 to 67+80. At these slopes and velocities, channel materials will be unstable and these sections of the channel should be lined.

Reinforced concrete box culverts are planned at the Geronimo Trail crossing from Station 62+90 to 63+70. The remaining length of the diversion channel, Station 68+80 to 95+80, will have slopes ranging from 0.002 to 0.0035 ft./ft. and a design velocity of 3.5 ft./sec. Channel materials in this section were considered to be fairly stable at this slope and velocity. This section does not need to be lined.

Deposition of sediment in the diversion channel does not appear to be a major problem since the sediment yield from the drainage area above the diversion is expected to be low.

Serious erosion of the diversion channel will not be a problem and deposition of excessive amounts of sediment in the channel is unlikely. A conscientious program of maintenance will be sufficient to assure the safe functioning of the diversion.

SEDIMENTATION INVESTIGATIONS

The sedimentation investigations included reservoir sediment surveys of six stock ponds whose watersheds represent varied topographic, soils, and cover conditions. Three of the stock ponds are located in mountainous terrain characteristic of the upper watershed. The residual soils on their watershed are developed chiefly from rhyolite rocks. Range conditions are good to excellent. Sedimentation rates in these stock ponds range from 0.1 acre foot per square mile to 0.85 acre foot per square mile. The high rate is due to the predominance of channel erosion in the watershed of one of the stock ponds.

The other three stock ponds surveyed are located in the Slopes Unit. The alluvial soils in this unit range from silty sands to sandy clays. These soils are commonly protected by a desert pavement of gravel and lime nodules. These stock ponds have a very low sedimentation rate of less than 0.01 acre foot per square mile.

Investigation of sediment source areas show that most of the damaging material comes from erosion of the deeper soils by sheet floods and gullying. Some of these soils were farmed in the past and a protective cover has not yet developed. Much of the land adjacent to Douglas is idle or laid out for subdivision and is subject to scour during floods.

Sediment storage requirements for the Floodwater Retarding Structures, No. 1 and No. 2, were based on the stock pond surveys and the effects of the proposed land treatment program. It is estimated that the average annual accumulation is about 0.1 acre foot per square mile of drainage area in both structures. Sediment storage requirements for the 100 year period are therefore 180 acre feet in Structure No. 2 and 150 acre feet in Structure No. 1. Due to the fine texture of the sediment, it is expected that about 80 percent of the volume will deposit in the lower portion of the basins and the remainder in the upper portion.

ENGINEERING INVESTIGATIONS

MAPS

United States Geological Survey 7½ and 15 minute quadrangle maps with contour intervals of 20 feet were used as base maps for planning.

SURVEYS

Topographic maps were made from field surveys of the Airport Diversion and the two Floodwater Retarding Structures, (FRS). Centerline profiles of the two FRS, the two floodways, and the Airport Diversion were surveyed and used as a basis for determining volume of excavation and embankment.

DESIGN CRITERIA

All structures were designed to control floodwater from the 100-year storm and convey it safely to Whitewater Draw. Additional capacity was provided in the two FRS to contain a 100-year accumulation of sediment.

Each FRS will have an ungated reinforced concrete conduit with inlet and outlet structures for a principal spillway. These spillways are designed to release the impounded floodwater from the 100-year storm in approximately ten days without using the emergency spillways.

The emergency spillway for each FRS was designed using Soil Conservation Service Standards for floodwater retarding structures in a hazardous situation, class "c".

The earth embankment and foundation required for each FRS was based on a study of foundation and fill materials. The nature and characteristics of these materials were determined by preliminary subsurface investigations and laboratory test results of soil samples.

Final design will be based on the results of detailed subsurface investigations to be accomplished after the watershed is approved for operations.

The floodways are designed to carry the 100-year storm inflow from the uncontrolled areas contributing to the floodways in addition to the maximum outflows from the principal spillways. The floodways will be stabilized with rock riprap throughout their length. The design of the rock riprap is based on Section VI, Engineering Design Standards - Far West States.

Airport Diversion is designed to convey the peak discharge from the 100-year storm to the reservoir area of FRS No. 1. The diversion was designed to carry these floodwaters without excessive erosion and deposition of materials. A portion of the Airport Diversion will be stabilized with rock riprap. The design of the embankment for the diversion was based on criteria for a Class I Dike in SCS National Engineering Handbook, Section 2.

ALTERNATE STUDIES

Two alternate plans were studied. One plan included two floodwater retarding structures, two floodways, and one diversion. This formulation required separate floodways serving as outlets from the two floodwater retarding structures and thence joining in one common floodway two miles west of FRS No. 1. It was determined that this formulation was more expensive than the connecting floodway formulation as used in this work plan.

The other alternate investigated included a system of collecting dikes and a channel with sufficient capacity to accommodate the 100-year flood to Whitewater Draw. This plan required enlarging three U.S. Highway bridges, one railroad trestle, and two county bridges. This plan proved to be more costly than the proposal shown in this work plan.

COST ESTIMATES

Cost estimates for structural measures are based on the preliminary designs for each measure and reflect current prices for similar work in this locality. Where local cost information was not available, costs of construction items, as shown in the engineer's estimate, were based primarily on costs of previous P.L. 566 contracts for flood prevention projects in Arizona.

Present land values were used as a basis for computing land rights costs and were determined in meetings with the local sponsors.

Costs for road relocations and utility crossings determined by mutual understanding between the concerned parties, the local sponsors, and the SCS are included in this item.

Cost of operation and maintenance of the structural measures were based on experience from similar structures, and adjusted to meet local conditions.

ECONOMIC INVESTIGATIONS

Basic data established for the 1957 flood event were expanded to calculate future damages. The files of the local newspaper, the Douglas Dispatch, were searched to acquire data on flood events and major storms. Newspaper reports included information on areas inundated, depths of flooding and property damage.

Property values were established by reviewing the assessed values of the urban property, by block, at the Cochise County Assessor's Office.

Local residents were interviewed following the July 24, 1957 flood concerning their immediate knowledge of the degree and types of floodplain damages. Key community leaders assisted in these interviews. The interviews established flood flows, depths of inundation, rate of building improvements, the value of contents as compared to the values of the dwellings and other pertinent depth-damage relationships. Studies included both residential and commercial properties.

Industrial properties were surveyed for flood damages by contacting each establishment.

Additional damage information was gathered on railroads, State and County highways, city property and public utilities from the appropriate authorities.

Secondary data from the University of Arizona gave information on industries, income, inventory of business and population growth rates.

The residential area of Douglas and Pirtleville were classified into six groups, based on present value, rate of growth, and type of growth. This was done because of the large areas of development in the Spanish American sections and the difference in development in other residential sections.

Average unit values of homes in these six groups range from about $2,600 in Pirtleville to over $20,000 in sections of Douglas.

Two major commercial areas are found in the watershed. These are the highly developed downtown commercial area and an area within the Railroad Addition in Douglas.

Indirect damages were based on empirical data ranging from 10 to 25 percent of direct damages. Indirect damage reduction benefits recorded on Table 5 are 16.52 percent of the direct damages. Lack of sufficient historical damage data on events other than the 1957 storm and the fact that routes of flood have changed over the years, presented some difficulties in projecting the 1957 data to other events. Frequency of occurrence vs discharge were plotted on probability graph paper for known events and extended to give discharges for unknown events. Based on the 1957 event, a projection of two other events were made. Discharge vs dollar damage curve was plotted on ordinary graph paper for each subwatershed. The dollar damage vs frequency curve was used to determine the average annual damage for each subwatershed and the watershed as a whole.

Other methods and techniques used in arriving at the average annual damages for this watershed were based on the procedures set up in the Economic Guide for Watershed Protection and Flood Prevention.

Residential and commercial damages were adjusted to reflect increases in future damageable values throughout the evaluation period. Adjustments are based on expected increases in the per capita personal income and personal income expenditures as estimated by OBE for the Gila water resource planning area.

Benefits are on an adjusted normalized base while costs were amortized at the interest rate of 4-7/8 percent prior to comparison.

Immediately adjacent to the southern most boundary of the watershed is Agua Prieta, Sonora, the twin city of Douglas, Arizona. The flood damage from the Perilla Mountain watershed to Agua Prieta, in the aggregate could be considerable but was not evaluated.

Land formerly cultivated has evidence of land scour. Loss of potential productivity due to land scour, land enhancement or restoration benefit was omitted. The economic loss from range depletion or erosion in this area was not calculated.

Proposed land treatment effects on reducing runoff were considered to be very minor because of climate, soils, topography and

projected land use. The land treatment program effects were therefore assumed to be one-half of one percent of the total flood damage reduction benefits.

Secondary benefits were not considered in project evaluation.

FISH AND WILDLIFE INVESTIGATIONS

Fish and Wildlife investigations were conducted by the Bureau of Sport Fisheries and Wildlife of the United States Department of the Interior in cooperation with the Arizona Game and Fish Department. The following statement, "The project as planned will have no significant effects upon fish and wildlife", was taken from a letter dated January 1, 1959 from the Bureau of Sport Fisheries and Wildlife.

Copies of the complete Fish and Wildlife report may be obtained from the Bureau of Sport Fisheries and Wildlife office at Albuquerque, New Mexico.

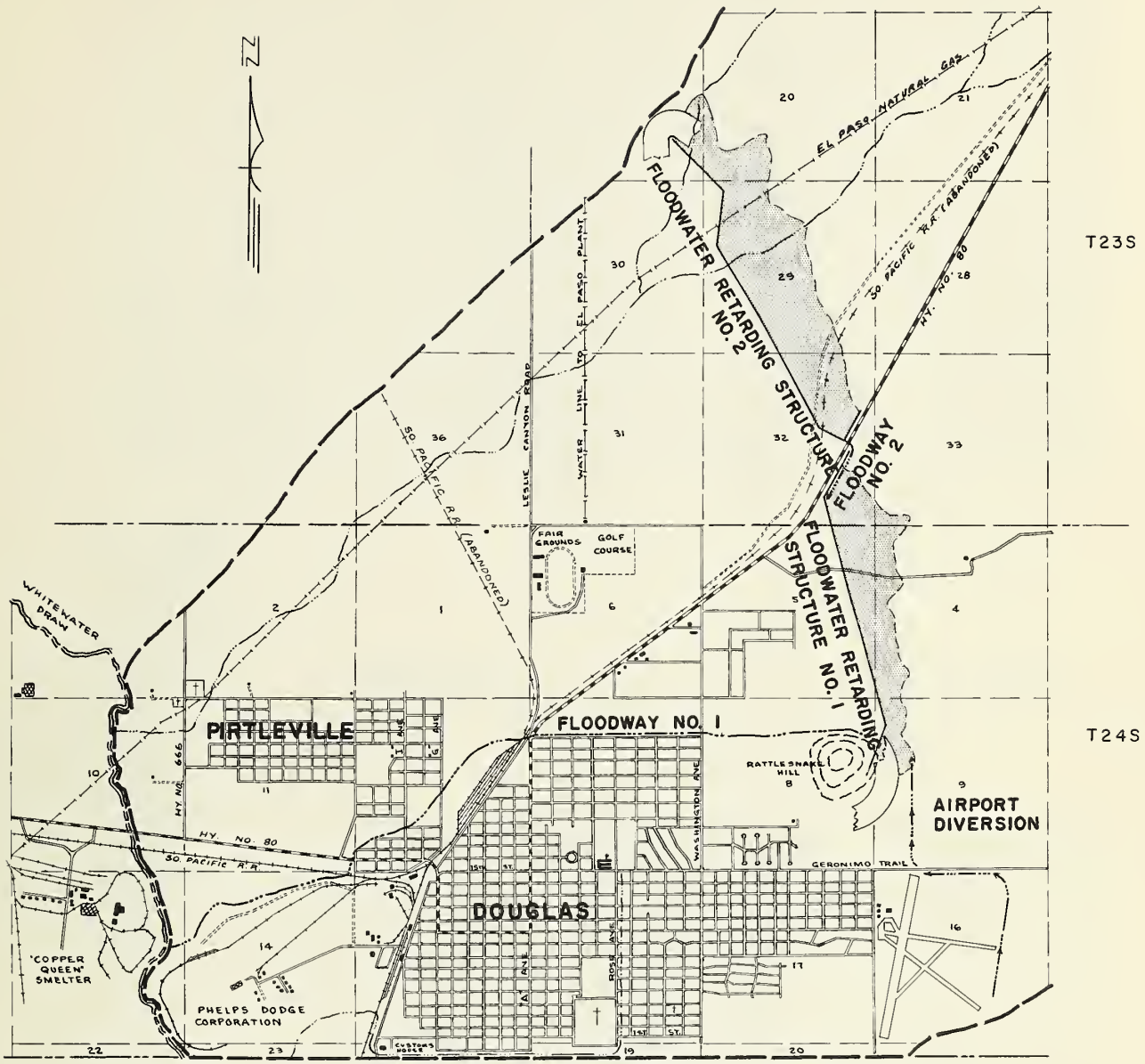


FIGURE 1(1)

LOCATION MAP

PERILLA MOUNTAIN WATERSHED

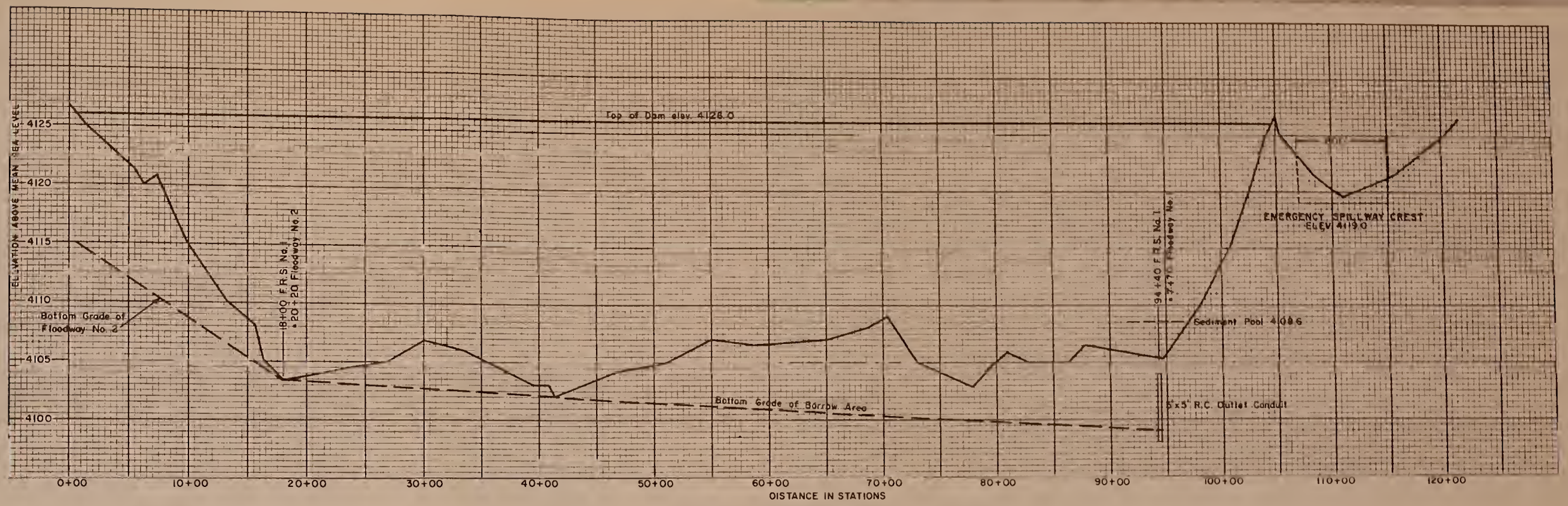
COCHISE COUNTY, ARIZONA

APRIL 1970

0 MILES

SCALE 1:63,360

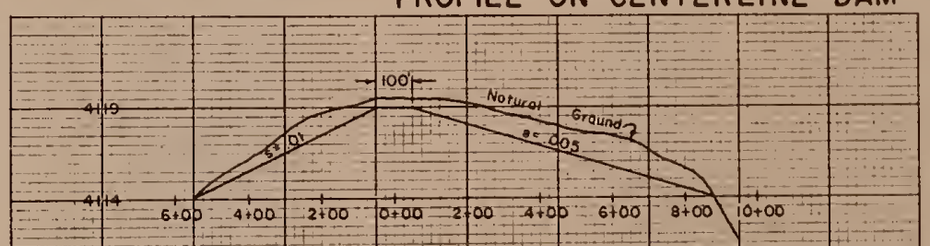
U.S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE USDA-SCS-PORTLAND, OREG. 1970 M-4321



RESERVOIR STORAGE DATA

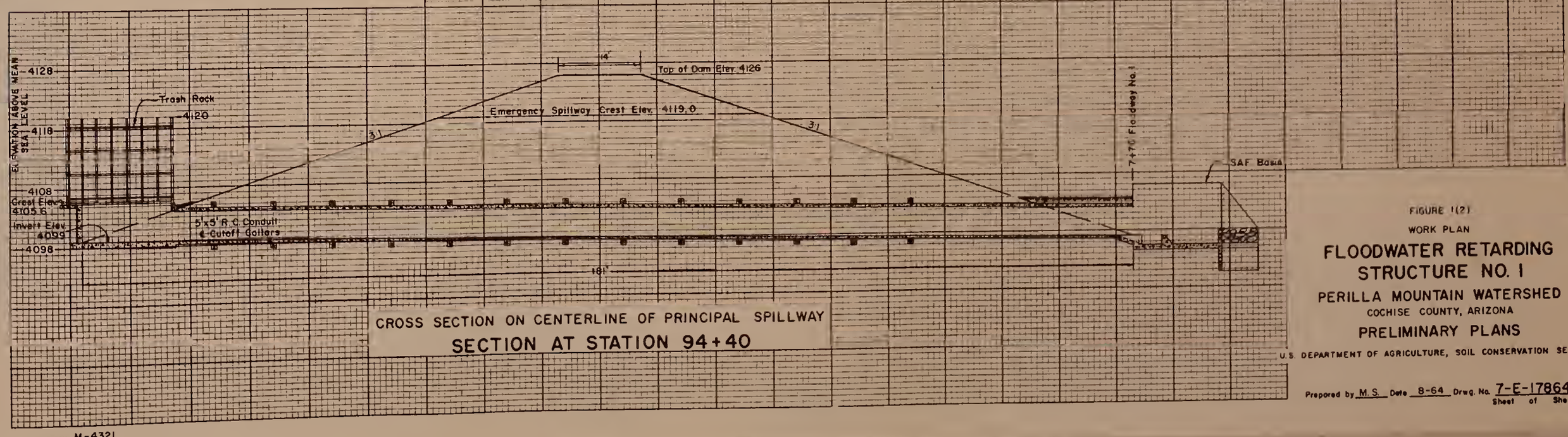
ELEVATION M.S.L.	AREA ACRES	STORAGE ACRE FT.	REMARKS
4103	0	0	
4105	10	10	
4108.6	58	150	Crest of Riser
4110	79	233	
4115	153	813	
4119	234	1640	Crest of Emergency Spillway
4120	252	1826	
4125	343	3314	
4126	360	3620	Top of Dam

PROFILE ON CENTERLINE DAM



EMERGENCY SPILLWAY PROFILE

TYPICAL EMERGENCY SPILLWAY CROSS SECTION



CROSS SECTION ON CENTERLINE OF PRINCIPAL SPILLWAY
SECTION AT STATION 94+40

FIGURE 1(2)

WORK PLAN

FLOODWATER RETARDING STRUCTURE NO. 1

PERILLA MOUNTAIN WATERSHED

COCHISE COUNTY, ARIZONA

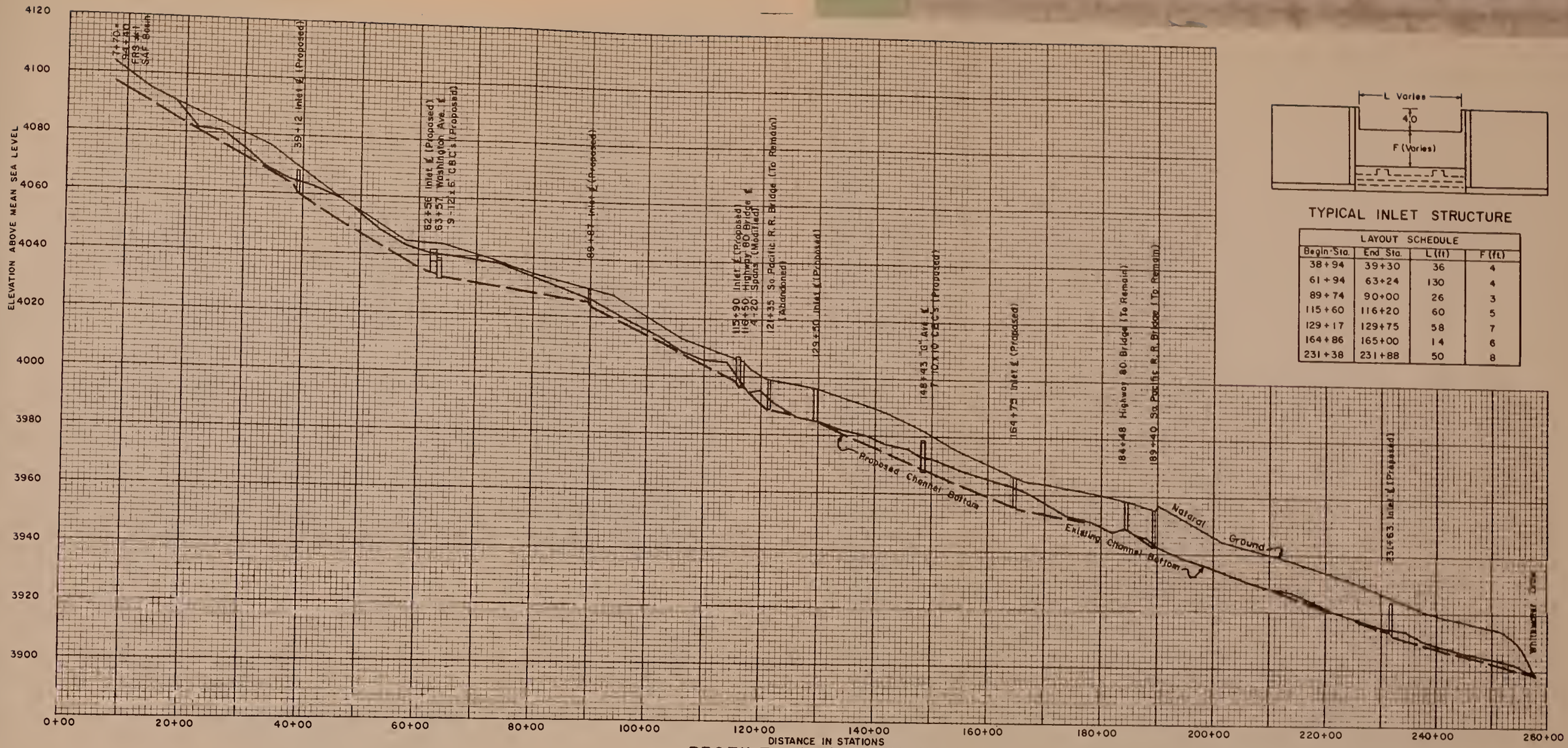
PRELIMINARY PLANS

U.S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE

Prepared by M.S. Date 8-64 Drwg. No. 7-E-17864

Sheet of Sheets

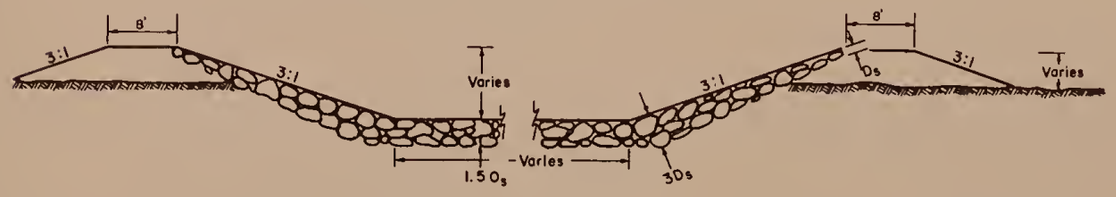
M-4321



PROFILE – FLOODWAY NO. 1

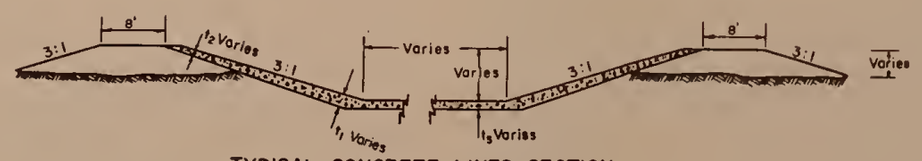
TYPICAL INLET STRUCTURE

LAYOUT SCHEDULE			
Begin Sta.	End Sta.	L (ft)	F (ft)
38+94	39+30	36	4
61+94	63+24	130	4
89+74	90+00	26	3
115+60	116+20	60	5
129+17	129+75	58	7
164+86	165+00	14	6
231+38	231+88	50	8



TYPICAL RIPRAP SECTION

LAYOUT SCHEDULE		
Reach	Begin Sta.	End Sta.
1	7+70	38+50
2	39+30	63+24
3	63+90	89+74
4	90+00	115+60
5	116+80	120+58
6	121+60	231+38
7	231+88	258+00



TYPICAL CONCRETE LINED SECTION

LAYOUT SCHEDULE		
Reach	Begin Sta.	End Sta.
1	38+50	39+30
2	89+74	90+00
3	115+60	116+20
4	120+58	121+60
5	231+38	231+88

FIGURE 2 (I)

WORK PLAN

FLOODWAY NO. 1

PERILLA MOUNTAIN WATERSHED

COCHISE COUNTY, ARIZONA

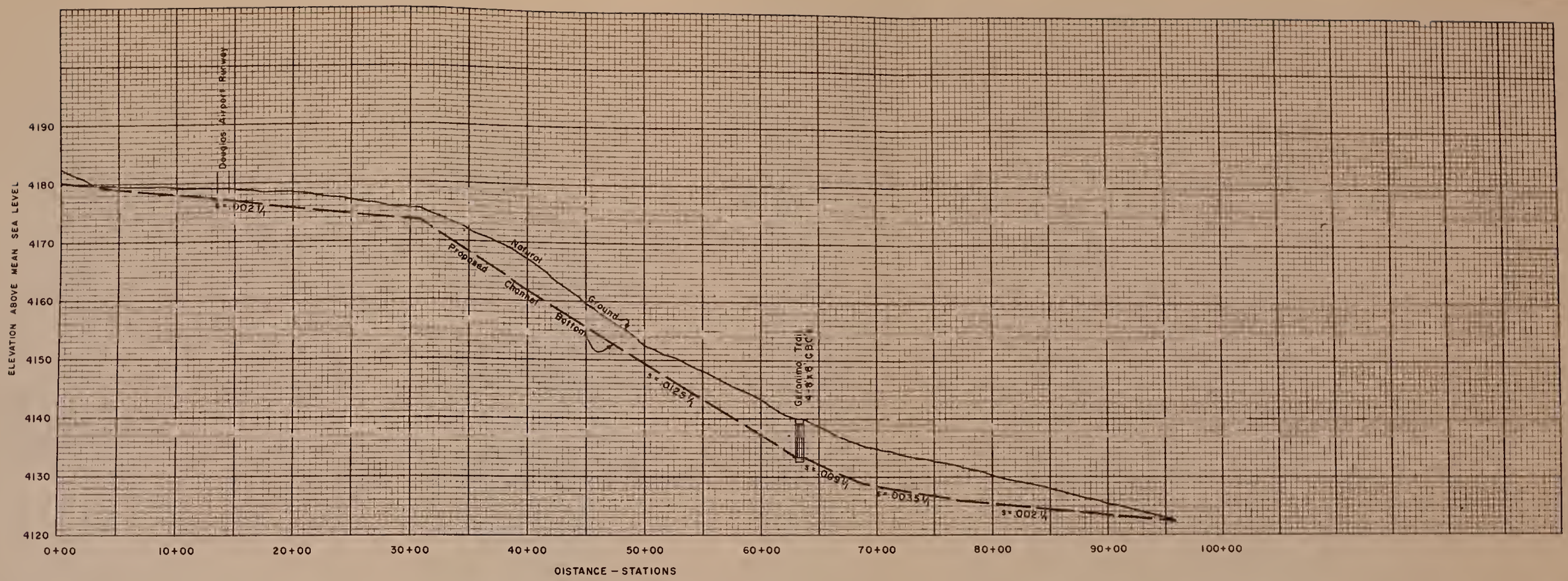
PRELIMINARY PLANS

U.S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE

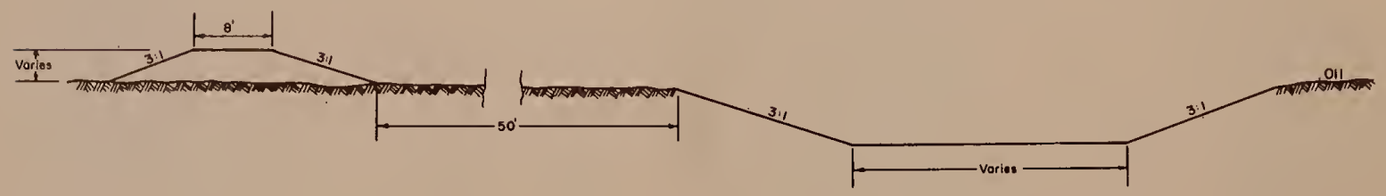
Prepared by M.S. Date 12-64 Drwg. No. 7-E-17864

Sheet of Sheets

M-4321

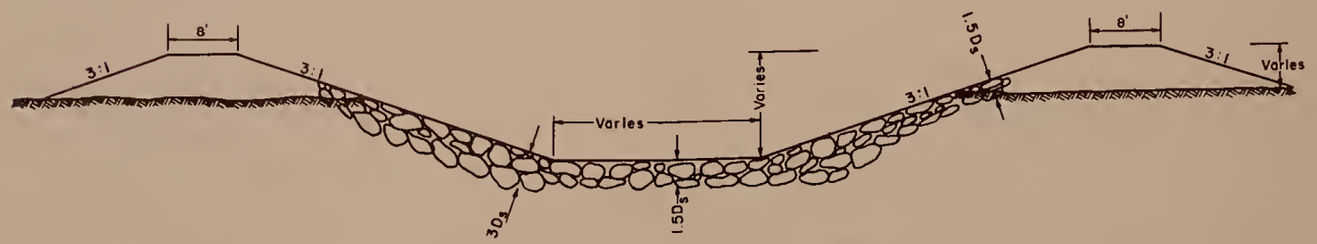


PROFILE ALONG CENTERLINE



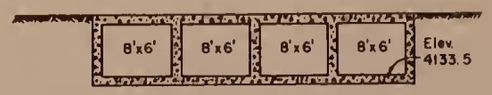
TYPICAL EARTH SECTION

Sta. 0+00 to Sta. 30+80
Sta. 68+80 to Sta. 95+80



TYPICAL RIPRAP SECTION

Sta. 30+80 to Sta. 68+80



GERONIMO TRAIL CROSSING

Sta. 62+90 to Sta. 63+70
45° Skew

FIGURE 2(2)
WORK PLAN

AIRPORT DIVERSION

PERILLA MOUNTAIN WATERSHED
COCHISE COUNTY, ARIZONA

PRELIMINARY PLANS

U.S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE

Prepared by M.S. Date 12-64 Drwg. No. 7-E-17864
Sheet of Sheets

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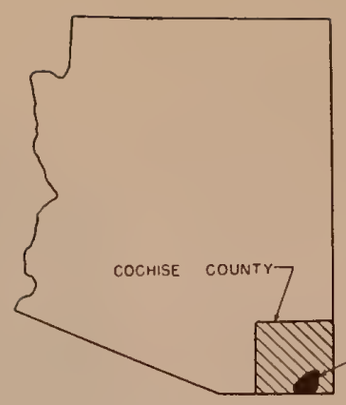


LOCATION MAP

LEGEND

- Private
- State
- National Land Reserve
- Urban, Industrial, Commercial
- Arable Farm Land

R 28 E.

T 23 S.

T 24 S

R.27E.

TO LORDSBURG NEW MEXICO

WATERLINE TO EL PASO GAS PLANT

EL PASO NATURAL GAS PIPELINE 12" DIA

US 80

SLOPES

HILLS

VALLEY

SP RR

ROAD

CANYON

TO WILLCOX

GOLF COURSE

FAIR GROUNDS

WHITEWATER DRAW

PIRTLEVILLE

"I" AVE

"O" AVE

TO BISBEE

US 80

"A" AVENUE

15th STREET

ROSE AVENUE

DOUGLAS

Customs House

1st ST

RATTLESNAKE HILL

DOUGLAS AIRPORT

GERONIMO TRAIL

"O" HILL

MEXICO

TO AGUA PRIETA

FIGURE 3

LAND STATUS, LAND USE AND RESOURCE UNIT MAP

PERILLA MOUNTAIN WATERSHED PROJECT

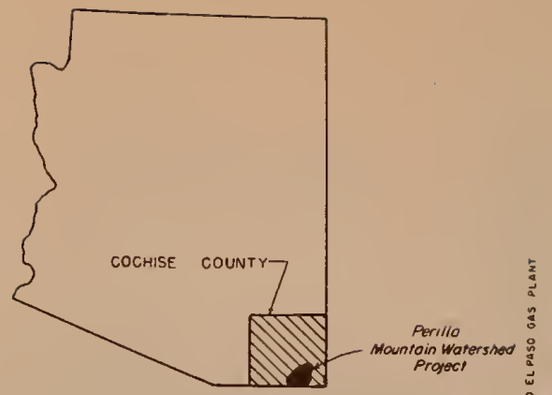
COCHISE COUNTY, ARIZONA

APRIL 1970

0 1 MILES

SCALE 1:63,360

U.S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE 9134-SCS-PORTLAND-OREG. 1970 M-4321



LOCATION MAP

LEGEND

- Drainage Area Controlled by Structure
- Area Benefited
- Floodwater Retarding Structure
- Floodway or Dike

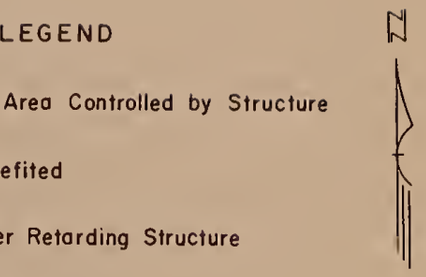


FIGURE 4

PROJECT MAP

PERILLA MOUNTAIN WATERSHED PROJECT

COCHISE COUNTY, ARIZONA

APRIL 1970

1 0 1 MILES

SCALE IN MILES

SCALE 1: 63,360

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FIGURE 5
URBAN FLOOD PLAIN
DOUGLAS, ARIZONA

LEGEND
- 100 YEAR FLOOD LINE WITHOUT PROJECT
- 100 YEAR FLOOD LINE WITH PROJECT
- DIRECTION OF FLOW

WHITEWATER DRAW
ABANDONED RAILROAD
HIGHWAY 80
FLOODWAY NO. 1
PIRTLEVILLE
HIGHWAY 80
DOUGLAS
UNITED STATES
MEXICO
AGUA PRIETA
N

PERILLA MOUNTAIN WATERSHED
COCHISE COUNTY, ARIZONA

FEBRUARY 1970

0 1/8 1/4 1/2 1 MILE

SCALE 1: 24,200

U. S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE USDA-SCS-PORTLAND, OREG 1970